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THE WORLD IS ITS FIELD

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THE GAS ENGINE FOR HEAVY MARINE SERVICE.

By Lewis Nixon.

It was said some time ago by one of the world's greatest leaders in engineering achievement, that the steam turbine was an intermediate step in power economy between the reciprocating engine and the internal-combustion engine. Now, close following upon the striking enlargement of the use of the turbine for ship propulsion, come indications that this may indeed be only a transitional step, and that the marine power plant may pass on even more rapidly than the land station to the machine of higher economy—the internal-combustion engine.

It is significant that while Mr. Nixon's training and sympathy would justify him in thinking first of naval and tactical advantages, he does not base his faith primarily on the military considerations which were given so much prominence recently by Mr. James McKechnie. He founds it on the solid principles which have always underlain the commercial supremacy of the seas—the ability to meet all conditions of ocean navigation more securely and more economically than any rival. In affording opportunities and a market for the development of the gas engine, its utility to the cargo carriers of the world will far outweigh its advantages aboard the fighting ships of war. And to this Mr. Nixon adds one consideration more—one of the newest to gain recognition as an important factor in industrial affairs—humane regard for the workers.—THE EDITORS.

IT is said of a prominent American statesman that when the pros and cons of expansion were being discussed in a tiresome way, he rose in his seat and said: "But we've done expanded!"

We see much in the press about the possibility of adopting the gas engine for marine propulsion. It is adopted!

Engineers found progress with the steam engine the easier owing to the 15-pounds gain by vacuum, and the fact that the earlier engines were not built to permit of service pressures great enough to make this gain negligible.

The demand upon the steam engine is greater and greater and the last stage is reached in superheating the steam and in the turbine. Steam at 250-pounds pressure is an agent hard to hold in bounds, and the slightest yielding means death by scalding and burning. The

engine force of a liner after a trip across the ocean look like battle-scarred veterans.

The turbine requires a very high vacuum for high efficiency and time only will tell how this will work out in service. But even with the best of conditions in steam service—and these conditions have so long been looked upon as necessary evils, that the pitiable life in an engine room receives but little attention—we must still hark back to the man-fired boiler, and it would require a Dante to paint here a real picture of the fire-room inferno.

Horse powers of a thousand in one-cylinder gas engines have been used now for years, and the economy is demonstrated to be superior to the best types of steam engines run under the most economical conditions when newly tested. Many such engines run for months without stopping for repair or overhaul. Simplicity, too, is a feature of the gas engine of extreme importance, and this influences its rapid development in a marked degree.

I know of no fact showing the simplicity more clearly than the general grasp of the automobile engine. This modern miracle of the Twentieth Century, which in comfort gives us on our highways the speeds of a railway train, is having an influence upon the world's progress in that it is bringing about an intimate personal touch with a prime mover and developing an understanding of mechanics which is becoming not only general but popular. The gas engine is easy to understand and control, and hundreds now run them where one can run a steam engine of like power. It helps the farmer cut his wood and thresh his grain and on large farms will soon do the ploughing and reaping.

Many a poor fisherman to whom age has brought waning strength and stiffening joints, finds in the gas motor a ready and easily understood means to continue his usefulness and earning capacity. On suburban lines it gives a flexible and always ready means of transportation independent of a central station and far more economical than electricity in first cost and maintenance. On railway cars it has demonstrated its ability to do as well as the steam-propelled car and it only needs use and further study of the problem to show its superiority.

I am convinced that gasoline and alcohol are the ideal liquid fuels for gas engines for marine purposes on torpedo-boats, destroyers, launches and scouts, and all other war-vessels of not over 20,000 horse power where great speed and endurance are required and weight and space must be reduced to the minimum. This is because

they are "liquid primary fuels," to use an apt phrase coined by Commander Willets, U. S. N., and can be used without atomizers or producers, so saving much additional apparatus and being always ready for instant application.

The danger, provided we have a proper installation of the gasoline tanks and connections, is far less than with steam of over 200-pounds pressure. We hear of a great many explosions of steam plants of late, especially where deterioration eats up the small margin possible with extreme demand—but think of the accidents which occur unchronicled!

Without going into the dozens of advantages, for an understanding of which I should advise reading the admirable paper of Commander Willets, U. S. N., read before the American Society of Naval Engineers, I will cite the following as the influences that force the recognition and ultimate almost universal adoption of the gas engine in place of the steam engine on the water:—

1. Simplicity.
2. Less strain on the engine force.
3. Less weight and space for the same power.
4. Greater economy.

There have been so many errors in stating what has been done and will be done in the near future that a short *résumé* is desirable.

In the first place not one, but *ten* torpedo-boats have been produced, of 35-tons displacement, carrying an 18-inch torpedo tube, a 47-millimetre rapid-fire gun and three automatic guns, with a speed of over 20 knots and an endurance of 2,000 miles. In proof that no sacrifice was made in scantling to produce results impossible with steam, a vessel of this type was run across the Atlantic in winter gales.

The auxiliary four-masted schooner Northland, of 3,000 tons deadweight, has a 500 horse-power engine, and the fishing excursion boat Arion a similar engine.

A destroyer has been designed of 625 tons having 12,000 horse power, and of 30 knots speed.

Another scout destroyer has been designed, of 1,800 tons, with 30,000 horse power and an endurance of 3,000 miles at 30 knots, every detail of which is well within the limits of results already proven out.

The producer problem has received the attention of the ablest engineers of the world, as the present wasteful use of fuel with steam cannot continue and the men who give their time and attention to re-

duce the fuel bill of the world and conserve its latent energy are rendering a service of supreme importance to mankind.

The hard-coal gas producer is now in very general use and is rapidly forcing the steam plant aside, especially in factory plants.

The soft-coal producer is giving good results but must be further developed.

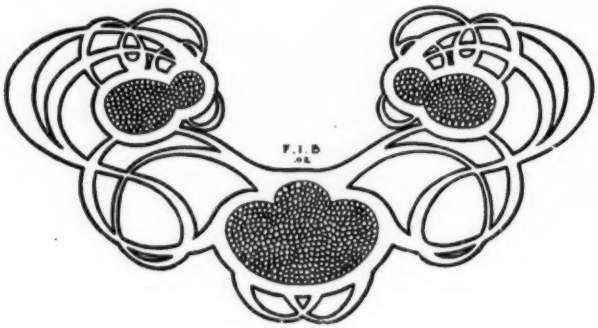
The next important development will be a simple and easily manipulated crude-oil gas producer.

With its coming as a commercial product we shall see the gas engine in future tramps, and with the advent of the first passenger liner its universal adoption on transatlantic passenger steamers will be assured.

Whether the steamer will be made smaller or not is hard to say, but very probably on account of the greater steadiness and the lesser influence of waves the vessels will continue to grow.

One hundred thousand horse power can be installed in the space and on the weight of 45,000 horse power of steam as put on a modern liner. The consumption of crude oil will be about 750 tons per day for such power.

The largest marine engine yet designed on proper proven-out data that I have knowledge of is a six-cylinder double-acting engine, 33 inch diameter by 33 inch stroke, developing 5,000 horse at revolutions less than 200—but far larger units are in use on shore, and their application on water is an easier problem than on land.



THE TECHNICAL STUDENT AND THE ENGINEERING APPRENTICESHIP COURSE.

By H. Cole Estep.

A FRANK STATEMENT OF A PREVAILING ATTITUDE

One of the most direct ways to a satisfactory agreement between two interests is through each one's understanding clearly the other's point of view. The courses and provisions arranged for their technical apprentices by some of the largest engineering concerns have been described in this Magazine by their founders or by those in charge of their administration.* Mr. Estep speaks for an important element of the student body which these courses are designed to attract and enlist. He speaks from intimate, living knowledge of the men around him—their ideas and their attitude. No one, we believe, will be more interested in a frank statement of this kind than the men who have carefully and conscientiously designed and administered the apprenticeship systems of the large employing companies.—THE EDITORS.

THE purpose of this article is to present a frank and intimate view of the present-day attitude of technical students toward the engineering-apprenticeship courses which are offered by practically all of the ranking engineering manufacturers of the United States. If this attitude is one not of sympathy, but of indifference; if college sentiment is turning away from rather than towards the apprenticeship idea—then the continued success of the system is in danger. The apprenticeship idea is fundamentally sound; much money and time has been spent in perfecting it; and now, if success is to be assured, we must be certain of the sympathetic co-operation of the men for whose benefit the system has been designed. Failure to secure this co-operation means that our costly experiments in apprenticeship courses will also end in failure. The success of the system varies directly with the quality of the men entering the courses, and this quality varies directly with the amount of sympathetic interest in the apprenticeship courses existing among the technical students of the country.

The first thing to determine in the investigation is, then, the present condition of student sentiment in regard to the apprenticeship

* See "The Training of Apprentices in the Westinghouse Works," by C. E. Downton, Dec., 1903; "An Example of the Modern Development of the Apprenticeship System" (Brown & Sharpe shops) by L. D. Burlingame, Jan., 1904; "Apprenticeship Systems of the Allis-Chalmers Company," by P. W. Gates, Apr., 1904; "Apprenticeship System of the Baldwin Locomotive Works, by S. M. Vauclain, June, 1904; also "Altoona and Its Methods," by F. B. Warren, on page 170 *et seq.*, this issue.

system. Is it one of warm sympathy, or of apathy; does the apprenticeship idea appeal to the majority of the best men in college, the men fitted to become the best engineers, or not; are the courses considered as an opportunity or as a last resort?

The writer has many friends in the large universities of the middle west and Pacific Coast, and for four years has been intimately associated with the students of the engineering college of one of the largest schools in the Mississippi valley, and his experience is that the attitude of the students toward these courses is apathetic and detrimental to the best interests of the apprenticeship idea. The young man graduating from his technical course generally thinks that the sacrifices involved in serving two years as an engineering apprentice are too great for the benefits to be derived therefrom, and so turns to the apprenticeship course only as a last resort, after he has tried to get a start in every other way and failed. Generally the answer to the question, "Will you take an apprenticeship course?" is: "Not if I can help it, or can get something better." As a whole the student body of American colleges are not sympathetically interested in the apprenticeship idea and only a few of them are attracted to it. While it is true that many good men enter apprenticeship courses upon graduation, and choose wisely, yet it is safe to say that there are three times as many who should take these courses and yet are not attracted to them, but avoid them. This is where the apprenticeship system is failing; it attracts only a few of the best fitted technical graduates, while the majority are not sufficiently interested in the idea to consider it seriously.

We will now turn to the discussion of the reasons for this state of affairs.

One of the first of these is that the courses offered by many firms are too stiff and inflexible. Every man is ground through the same mill, regardless of his individual requirements or previous experience. The resulting dissatisfaction is infectious, and the knowledge of it spreads through the student world much more rapidly than does the testimony of apprentices who are satisfied with their work. To this defamatory advertising, given the apprentice courses by men justly or unjustly dissatisfied with their lot, must be added that which comes from the lips of some of the employees of large engineering firms who seem to take particular delight in discrediting the apprenticeship system of the particular company employing them. I have met a number of them (fortunately there are not many) who pointed with pride to the fact that they had attained their own positions with-

out the necessity of two years at apprentice wages, adding that, anyhow, the apprenticeship course is valuable only to men having a "pull." As is usual in such cases the words of distrust circulated by these men are well-known among technical students, while the testimony of the hundreds of men who have found their courses to be of great benefit is seldom heard.

It is unfortunate that there is disseminated among technical students so little *precise* information in regard to the apprenticeship courses, with which most of the unreliable reports now afloat could be contradicted. The average student's idea of the details of the various apprenticeship courses is very hazy. The present-day lack of effort to acquaint the undergraduate with exact knowledge of these courses is a serious mistake in the administration of the system; and the publication and thorough distribution of descriptions of the courses offered by the various companies, at least as detailed as the average college catalogue, would do a great deal toward changing the student's attitude toward the apprenticeship idea. It is customary for the companies to send men to the various colleges to lecture to the students on their apprenticeship courses. This policy is admirable, but the administration of it is poor. The lectures are too general and do not tell the student what he wants to know. I have attended a number of them, and while they were interesting and copiously illustrated talks, they dealt too much with "glittering generalities" and contained extremely little *definite* information. The natural conclusion is that the companies, having something to hide, do not care to have the exact details of their courses known. This, together with the unreliable stories in circulation, causes the prevalent harmful feeling of distrust and skepticism about the apprenticeship idea. A systematic campaign of publicity is needed to remedy matters.

Investigation among technical students reveals, aside from the question of wages, three principal objections to the apprenticeship courses: first, the courses are too long; second, there is no reward at the end; and third, the invention clause existing in many apprenticeship contracts is unfair.

As to the first objection, it is doubtful if the courses could be made any shorter without impairing their efficiency. But much could be done to remove this complaint if more information in regard to the work accomplished during the two or three years was current in college circles. The same is true of the second objection; it too would be practically removed if exact information in regard to the subsequent successes and rewards of the apprentices was more generally

disseminated. These two complaints are caused principally by the same careless advertising of the apprenticeship system that was discussed in a preceding paragraph. College men are not to be lured into the apprenticeship system by meaningless generalities and dogmatic assertions, but would easily be convinced by a straightforward presentation of the specific facts of the case. So far as the invention clause is concerned, it would be good policy to abandon it. This contract required of apprentices, to consign *gratis* to the company inventions which may be worth hundreds of dollars, is not fair. Even if the company gives the apprentice the opportunity and time to make the invention, it still must be admitted that, if the invention is of any value at all, it is worth much more than the amount included in the apprentice's wages. Inventions of value made by apprentices should be treated individually and in a businesslike way. The cost of patents and preliminary development should be charged to the apprentice, and then a fair price or royalty should be paid him for his invention. The adoption of this policy would do a great deal to remove the impression, so noticeable among technical students today, that the companies "are out for all they can get" out of an apprentice.

To the average college man, who has spent four of the best years of his life acquiring a technical education at an expense of from $1,000 to $3,000, the pay offered the engineering apprentice seems ridiculously and discouragingly small. This question of wages is the most important and difficult problem that arises in the administration of the apprenticeship system. The problem is by no means solved. It is claimed that the present rate of pay is all that the average apprentice is worth, and that to this he should add the value of the education he is receiving. It is also claimed that the apprentice often takes the time of very valuable men, which must be charged against him. This latter argument has little foundation in fact. The apprentice usually is given a few brief instructions by the foreman or superintendent, and then save for an occasional hint is left to shift for himself. But be this or the other arguments what they may, the fact remains that the present rates and *methods* of paying engineering apprentices are responsible, more than any other one cause, for the lack of sympathy in the apprenticeship courses now existent among the student body of the colleges. Many men are financially unable to stand the expense of an apprentice course. This is specially true of the graduates of colleges in the Western States, and many good men are lost to the apprenticeship courses for just this reason. College graduates are often heavily in debt for their education and it is imperative to them that

some paying employment be found. The result is that the apprenticeship course, though it may pay well in the end, is not considered. The first thing to do in remedying matters would be to change the whole system of wages and abolish the repellant and discouraging flat-rate system now so extensively practiced. Apply the same common-sense methods to the apprentice-wage problem that have met with such success in dealing with the wage question in general—that is, abandon the antiquated flat rate and adopt the modern piece-work and premium system. This would be fair to all concerned. If the apprentice had the ability and skill he could then earn as much as the journeyman machinist working in the shop by his side; if not, he would have only himself to blame. In the drawing room and office pay him the average, fair rate based on his *individual* experience and ability. Then charge up to him the legitimate expenses of his course, the waste and breakages, the cost of the instruction and the other items. This system, though requiring time, tact, and judgment to administer, would be well worth while. It would make the apprenticeship course a much more attractive proposition to the man about to graduate from college.

Summarizing our investigation we find that the attitude of the American technical student toward the apprenticeship system is apathetic and not sympathetic; that the principal cause of this apathy is two-fold, first because the advertising of the system is general where it should be specific, second, that the present, low, flat-rate system of wages is discouraging rather than encouraging to the average college man. The thorough practical training acquired in an apprenticeship course is an essential element in every successful engineering career, and it is to be hoped that the present apathetic spirit of technical students will be so transformed that the future history of the engineering-apprenticeship system will be that of continually increasing usefulness.

THE JUNIATA SHOPS, LOOKING FROM THE HILL.

A RAILROAD UNIVERSITY. ALTOONA AND ITS METHODS.

By Frederic Blount Warren.

Academic instruction in the mechanical side of railway engineering serves, at best, as a ground-work on which to base the highly intimate and specialized knowledge of actual practice which present industrial conditions demand of the railway engineer. All railroads have recognized the necessity of especially training young men by contact with actual working conditions before entrusting them with positions of responsibility, and, to this end, several of the more important railroads have established more or less elaborate apprenticeship courses open to graduates of technical schools. The present article describes the system employed by the Pennsylvania Railroad, whose immense shops at Altoona offer a unique opportunity for thorough and comprehensive training.—THE EDITORS.

MORE than 10,000 men are in daily attendance upon the largest railroad university in the United States, which is conducted by the Pennsylvania Railroad at Altoona, Pennsylvania. Altoona is a busy little city of 50,000 persons and for the month of December, 1906, 13,000 men received at that point pay checks aggregating $825,000 from the one corporation which practically controls the destinies of the municipal population.

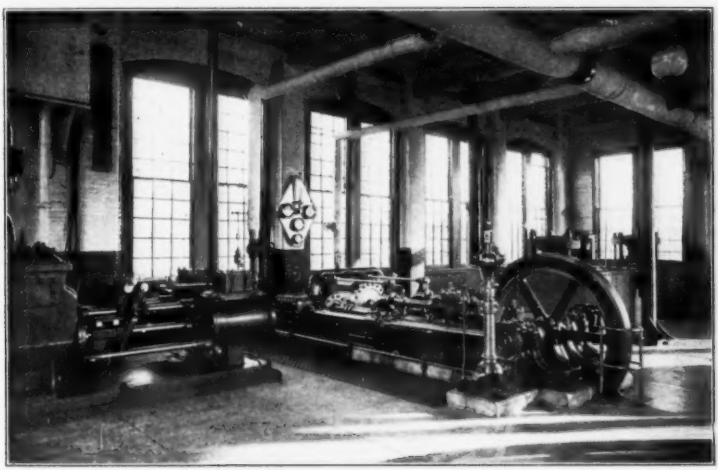
First of all, Altoona is a railroad city, where the industries, clubs, churches and society exist in a railroad atmosphere. It is the home of the largest freight yard in the world, this being 7 miles long from end to end and accommodating a total of 221 miles of track. In one month last year 154,442 cars passed through the town. Dozens of trains, laden with coal, come from the mountain districts every day; the cars are separated and classified and the new-made trains roll eastward. The total movement of freight cars through the Altoona yards in one year was 2,004,603; the average a day is about 6,000 cars Ninety-nine freight trains have been known to come in from the West in a single day of twenty-four hours.

Four important branches of railroad work are quartered and conducted here, affording the student of railroading a more thorough technical training than he could obtain at any other point in the United States. They are: the machine shops, I. B. Thomas, master mechanic, where locomotives are repaired; the car shops, W. F. Eberle, general foreman, where new cars are built and old ones repaired; the Juniata shops, W. H. Bennett, master mechanic, where only locomotives are built and none are repaired, and the South Altoona foundries, E. McLean, general foreman, where car wheels to the number of 900

THE JUNIATA BOILER SHOPS, SHOWING RIVETING MACHINES.

daily are made, as are also general castings for locomotives, cars, and miscellaneous work.

The Juniata plant is the only locomotive shop in the United States owned by a railroad and exclusively devoted to the building of locomotives. The Altoona machine shops are the best known in the country. At the present time they are repairing about 200 locomotives a month. The shops were commenced in 1850, four years after the road was completed over the Allegheny Mountains. Each of the three erecting shops has three longitudinal tracks, two of them have three overhead traveling cranes each, and the third shop has two supplemented by three electrical wall cranes on each side of the shop.



HYDRAULIC PUMPS IN THE JUNIATA SHOPS.

Already one of the best equipped plants in the United States, the Juniata shop increases in size or is improved in some way almost every year, but the following extensions were made in the main during 1902 and 1903. The original structure of the machine shop was 75 by 258 feet, two stories high; erecting shop 70 by 354; blacksmith shop 80 by 306; boiler shop 80 by 386. This shop was extended in length to 722 feet and the runway of its crane was extended 160 feet beyond the end of the shop for the purpose of handling supplies stored in the yard. The blacksmith shop grew to a length of 514 feet and an additional blacksmith shop 80 by 210½ feet has been built. The machine shop has been more than doubled in length, being now 578 feet 6 inches. The erecting shop is now 579 feet 9 inches in

length. The boiler house, originally 45 by 70, was enlarged to 45 by 151 feet. The original office building provided space for the care of stores, but in order to provide additional space for both of these departments a new storehouse was erected, 45 by 151 feet 1¼ inches in dimensions. The travelling-crane runways of the machine shop were extended to 60 feet beyond the west end of the shop.

Raw material comes in at one end of the boiler shop and as it passes along through the building is sheared, flanged, punched, assembled and riveted and finally passes out at the opposite end without having gone over the same path twice.

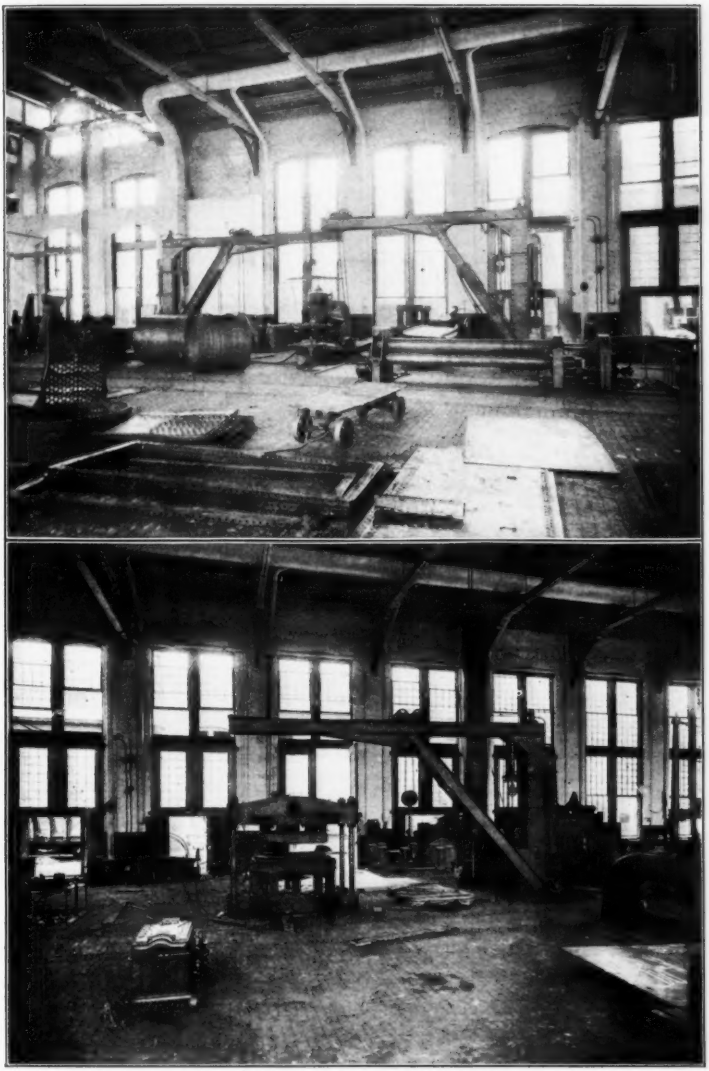
The whole operation is similar to the passing of an earnest student from class to class, each year adding to his store of knowledge till at last he emerges from the shops of learning a completed product.

Upon completion the boiler goes into the erecting shop, the end of which is directly opposite that of the boiler shop. The blacksmith shop is beside the latter. From the former the frames and forgings enter the machine shop, which occupies the same relative position to it as the erecting shop does to the boiler shop. The lay-out of the machine shop is such that the forgings are finished as they pass through without going over the same path twice, and they reach a completed stage at about the center of the building. The cylinders and other castings enter the machine shop from the opposite end, and after going through the various machining operations they reach a completed stage where they meet the frames and other forgings.

From this point the parts go in company through a side door to the erecting shop, and are there met by the boiler which has come in from the boiler shop. In one section of this shop the wheel centers are turned and bored, the axles and crank pins are turned, the tires are shrunk on, and the wheels completely assembled. Lighter machine work, such as making bolts, pins, staybolts, main and parallel rods, valve-motion work and the like, is done on the second floor of the machine shop, but this does not affect the general plan of things.

Locomotives to the number of 275 comprise the annual capacity of the Juniata shop. At the present time about 1,462 men are employed, exclusive of the heads of departments, together with the clerks and all others employed by the month, and are distributed as follows: boiler shop, 490; machine shops, 511; blacksmith shop, 298; erecting shop, 201; yard, 43; carpenter shop, 30; boiler plant and engine room, 33; paint shop, 24; scale department, 12.

While no further extensions are under way at the present time, the lay-out of the shops is such as to enable the main shop buildings to be

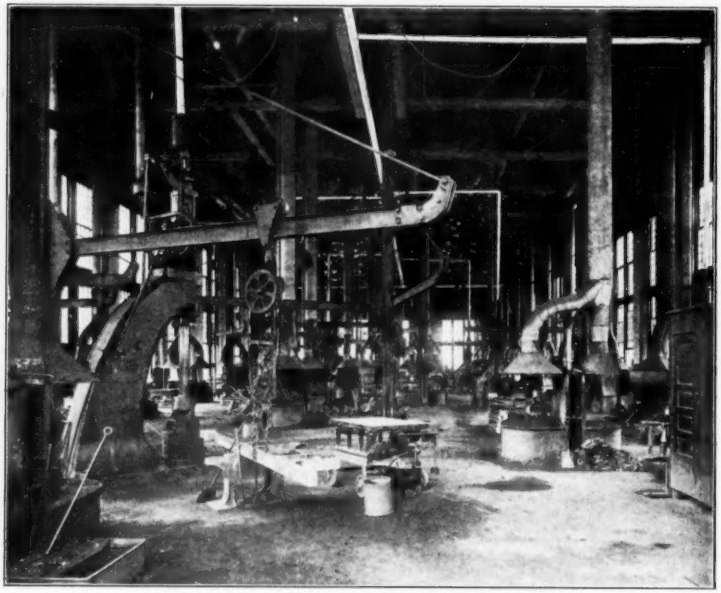


IN THE BOILER SHOP.

Below, the flanging press; above, the bending rolls and hydraulic punches.

duplicated, thereby affording possibility of an output of 500 to 600 locomotives a year.

From all over the Pennsylvania system east of Pittsburg cars and locomotives by the thousand are sent to the machine shops to be repaired, and in consequence the total floor area of nearly 80 acres in the shops is none too large, even without the heavy rushes that frequently occur.



BLACKSMITH SHOP, WEST END; JUNIATA SHOPS.

To take advantage of these extraordinary facilities students gather and learn railroading from the bottom up. "Silk stockings" find no places for them; there is the ultimatum of work or departure. And it is dirty, grimy work that severely tests the measure of young men. However, a graduate is splendidly equipped as a result of his apprenticeship.

The young men who come to take a course in the shops are called special apprentices, and they are put to work in the blacksmith, tool, wheel, tank, and boiler departments; then they learn how to keep accounts in the shop-clerk's office. Still more time is spent in the drawing room under the supervision of Axel S. Vogt, the mechanical engineer of the road, or in the laboratory. Throughout the course

the apprentices are carefully watched and directed. A record of every man's performance is kept. The only educational requirement for admission to the course is that the applicant be a graduate of a technical school or college. There are four years in the course, divided as follows:

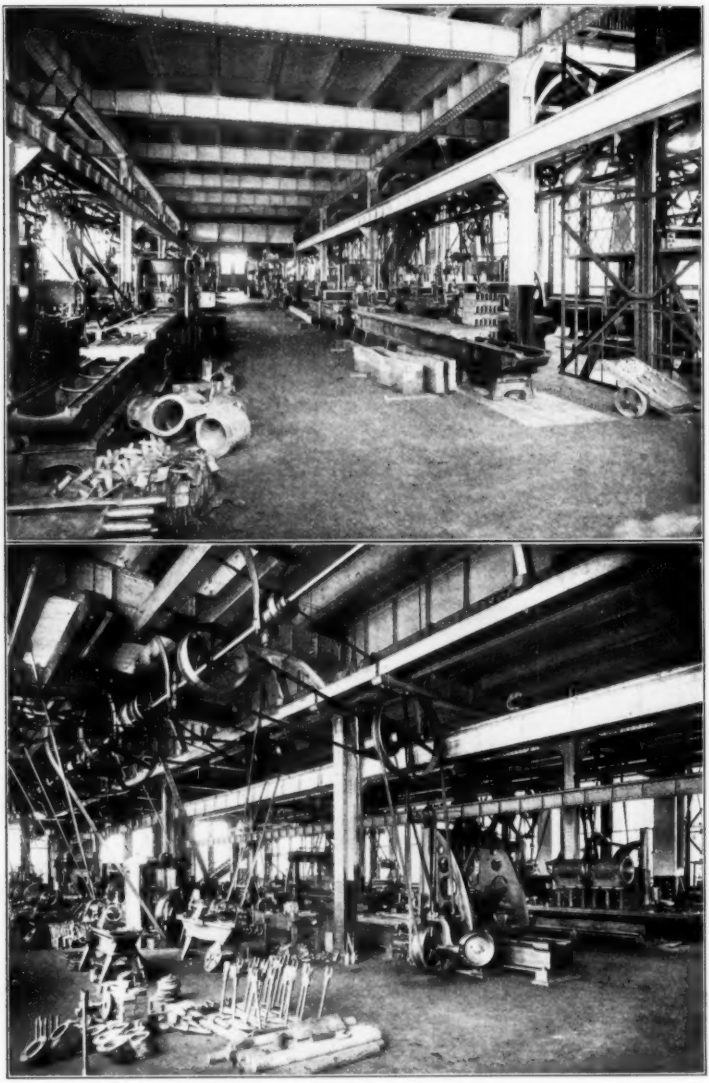
Erecting shops	6 months	Machine shop	6 months
Vise shop	3 months	Air-brake shop	2 months
Blacksmith shop	2 months	Iron foundry	2 months
Boiler shop	2 months	Car shop	6 months
Roundhouse	4 months	Firing on road	3 months
Shop-clerk's office	2 months	M. P.'s office	2 months
Test dept.	5 months	Drawing room	3 months

No text book is used, nor is any special reading required in the special apprentice system, which has been in operation since 1871. The superintendent of motive power is in charge of the course.

ELECTRIC PLANT, HYDRAULIC AND ELECTRIC BUILDING.

Any man available to rise to the highest positions usually goes through the grades of inspector, assistant master mechanic, assistant engineer of motive power, assistant road foreman of engines, road foreman of engines, master mechanic and superintendent of motive power. Naturally enough the line of promotion is not fixed by any rigid rule.

Many bright young men of good parentage, having passed through college and being vouched for by one of the general officers of the company, put on jumpers and spend several years in the shops in order to fit themselves for higher work in the railroad service. And that



FIRST FLOOR OF THE JUNIATA MACHINE SHOPS.

The lower view shows the west end; the upper, the east.

ERECTING SHOP, WHEEL AND AXLE DEPARTMENT.

they may attain their ambition is shown by the case of Frank Thomson, a former president of the system, who was a graduate of this manual-training school. It was in the Pennsylvania Railroad shops that he became thoroughly conversant with railroad construction.

Students of railroading at Altoona learn that to take care of the steady flow of traffic, increasing day after day, week after week, a remarkable machinery of yard management and train manipulation has of necessity been developed. The intricacy of it causes dizziness in the head.

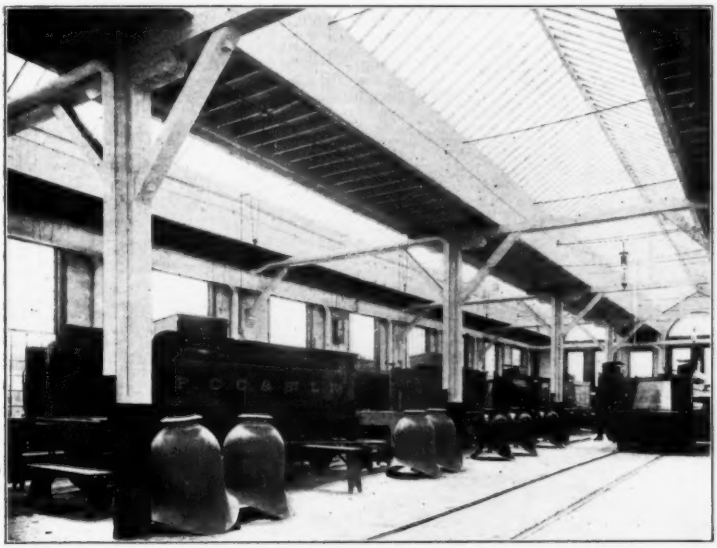
Smoke-hung, dirty freight trains in excess of fifty steam daily into the yards, shunt their cars along the tracks, where new trains are made up by a force of twenty-five yardmasters and assistant yardmasters who have charge of the work. Under them are hundreds of clerks, car makers, lever men, switchtenders, enginemen, conductors and brakemen.

In the department of the principal assistant engineer are gathered from all points on the lines East—this meaning Pittsburg—young civil engineers eligible for promotion to the position of assistant supervisor. These youths, after completing their education at technical schools and colleges, have entered the service of the company either in the construction department or in the offices of division superin-

THE SECOND STORY OF THE MACHINE SHOP.

The east end above; the west below.

tendents. As they show fitness they are sent to Altoona, where a record is kept of their age, education, and previous experience. They become acquainted with the general routine of the maintenance-of-way work and with the Pennsylvania methods of operating a railroad. From this force men are appointed assistant supervisors. Then in order of seniority they become supervisors, assistant engineers, superintendents.



THE PAINT SHOP.

There is nothing for which the increasing prosperity of the United States has created a greater demand than trained railroad men. As there is no railroad school or college in the United States, Altoona is the best substitute for such institutions and it has grown to vast proportions and become, in reality, the *alma mater* of railroad men. No like parallel is presented by any other city. Altoona is the last word in practical railroad education. After completing the course two things are still to be gained, things that come gradually to men in the making—executive experience and equilibrium.

In Altoona are gathered a number of the principal operating officials of the road and with them their families. At best the city is not a garden spot, and a pressing problem proved to be the arrangement of social facilities for the railroad employees. Therefore, just as they

would set about the building of a new roundhouse or car shop, in the same businesslike manner, the railroad officers attended to making conditions as agreeable as possible for the men. The Altoona cricket club, which had been in existence for many years, was converted into a club for the officers of the maintenance-of-way, motive-power, and other departments, and the special apprentices. The club is located on a high hill which rises far above the valley in which run the railroad tracks. Golf links, tennis courts, indoor games, and all of the appointments of a well-regulated club are provided. For the men employed by the railroad company the Y. M. C. A. has club facilities, and nowhere has such a branch of this organization been more thoroughly developed.

RECEPTION HALL OF THE ALTOONA CRICKET CLUB.

During the latter days of February the city of Altoona added to its educational facilities a railroad high school, which is the first institution of its kind in the United States. Its progress may mark the beginning of a new era in education, if other industrial corporations see the advantages of forming such a working partnership with the public schools as the Pennsylvania Railroad has made in Altoona. The industrial department of this high school is fully equipped and all bills are paid by the railroad company. The department has nothing in common with manual training. A four-year's course is planned, beginning with mechanical drawing and ending with machine design. The creation of the department is the result of a desire on the part of

the railroad to discover a way to combine its needs for trained employees with the aim of the public-school authorities to turn out young men ready to earn a living.

A drawing room, carpentry shop, forging room, a wood and metal-working machinery department—all equipped with modern tools —together with the expert instruction to be provided, will enable the school to give students advantages heretofore enjoyed only by pupils of the best technical schools.

Graduates of the Altoona high school will be fitted to go directly into the Pennsylvania shops on a footing between the regular apprentices, who, as a rule entirely lack training, and the special apprentices who are graduates of technical schools. The railroad's return on its investment is expected in the form of better educated employees.

The Pennsylvania does not alone bear the indebtedness to Altoona for thousands of its principal men, for many other railroads have drawn operating officials from among those who have learned the art of transportation here. When the International Railway Congress met in the United States two years ago one of its chief purposes was to visit the "greatest railroad town on earth."

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

II. THE DEVELOPMENT OF WATER-POWER AS A COMMERCIAL ENTERPRISE.

IN a preceding article, the first of this series, hydro-electric power was arrayed against steam power by comparisons of source, agencies, operation, and economies. These represent the evidence on which must be based the claims for the superiority of electric motive power in industrial establishments, and for water power as the primary source for these and central plants; whether or not the case has been made out rests with the reader.

Practice is founded on theories; but, no matter how logical and conclusive may be the deductions, their application alone carries conviction. The Niagara hydro-electric development may properly be cited as representative of all that has been said of electric-power application; here the electric current grinds flour and operates elevators; wood is reduced to pulp and manufactured into paper; soda ash, bleaching powder, carborundum, calcium carbide, aluminum and other products are manufactured by electric current; ship building, car wheels, structural steel, steel and malleable-iron casting plants, all employ electric power; a malt house uses 300 horse-power; a bakery and an ice plant are driven by electric current, and this power operates the Niagara, Buffalo and extensive suburban traction systems, and lights several cities and thousands of houses. This is an illustration of the central hydro-electric plant, furnishing power to shops, mills, and public plants, without restrictions of location or distance and independent of the uncertainties of fuel supply, at a cost far below that of the most economical steam-power service.

It is true that the Niagara hydro-electric development is the largest in existence; but this fact does not disqualify the comparison, as it differs from other existing plants or as yet undeveloped opportunities only in volume of output. The unit cost of this output, up to its present scope, is no lower than can be and is secured under normal conditions with the smallest developments.

The following is a partial list of American cities which are served with hydro-electric power of 1,000 horse power and more, and the distance from the point of development. Almost all of these services have been created during the last decade:—

City.	Horse Power.	Miles.	City.	Horse Power.	Miles.
Montreal, Can.	46,000	85	Sault Ste. Marie, Mich.	50,000	2
St. Catherines, Can.	8,000	22	Minneapolis, Minn.	7,500	10
Hamilton, Can.	8,000	35	St. Paul, Minn.	4,000	25
Port Arthur, Can.	10,000	22	Joliet, Ill.	4,500	8
Quebec, Can.	3,000	7	Richmond, Va.	12,000	28
Toronto, Can.	7,000	80	Petersburg, Va.	3,000	3
Niagara, N. Y.	55,000	..	Fredericksburg, Va.	4,000	3
Buffalo, N. Y.	40,000	23	Roanoke, Va.	3,000	13
Albany, N. Y.	32,000	40	Montgomery, Ala.	3,500	30
Massena, N. Y.	35,000	3	Salem, N. C.	2,000	14
Hudson, N. Y.	3,000	38	Augusta, Ga.	3,600	2
Utica, N. Y.	5,400	12	Athens, Ga.	2,200	..
Rochester, N. Y.	3,200	56	Columbia, S. C.	7,000	..
Lewiston, Me.	3,000	20	Anderson, S. C.	3,000	10
Portland, Me.	2,660	13	Rock Hill, S. C.	4,000	..
Sanford, Me.	2,000	9	Salt Lake City, Utah.	10,000	37
Manchester, N. H.	5,370	14	Logan, Utah	2,800	40
Concord, N. H.	1,000	4	Butte, Mont.	10,000	65
Montpelier, Vt.	1,670	..	Helena, Mont.	12,000	11
Attleboro, Mass.	1,260	..	Colorado Springs, Colo.	1,800	25
Springfield, Conn.	3,780	6	Pocatello, Idaho	1,200	30
Hartford, Conn.	4,000	11	Seattle, Wash.	8,000	38
Easton, Pa.	1,500	4	Tacoma, Wash.	1,400	45
Lancaster, Pa.	1,000	..	Spokane, Wash.	6,000	42
Grand Rapids, Mich.	3,000	40	San Francisco, Cal.	15,000	220
Kalamazoo, Mich.	2,000	20	Sacramento, Cal.	4,000	23
Muskegon, Mich.	1,000	15	Los Angeles, Cal.	10,000	83
Jackson, Mich.	1,800	18	Fresno, Cal.	2,000	56
Cheboygan, Mich.	3,000	6			
Buchanan, Mich.	2,000	18			

There are now under construction hydro-electric developments which are reported to represent an aggregate capacity exceeding half a million horse power, or about as much as is represented in the list here quoted, and nearly one third of these developments are located in the Southern States. The increase of water-power development in the United States from 1890 to 1900 was, according to the Census, from 1,263,000 to 1,727,000 horse power, and it may be expected that the end of the present decade will show an aggregate of two and a half million horse power of developed water power. It goes without saying that almost all this entire increase will be represented by hydro-electric output. No better evidence need be presented to sustain the claim that hydro-electric power will displace steam for central plants wherever practicable, which actually means that, sooner or later, every available water power will find its utility as a source for hydro-electric power service.

It is not the purpose to enlarge unnecessarily upon this topic by presenting any statistics of the growth of the application of hydro-electric power in industrial plants; the very list of central plants gives ample evidence of this and a few typical examples will substantiate all that has been claimed for electric motive power as against steam in shop and mills.

Of the more important shops in the United States where electric power was first introduced the Baldwin Locomotive Works in Philadelphia are among the most widely known. It was there applied, in the words of E. H. Sanborn, (Twelfth United States Census):—

> "First in the erecting shop for driving two 100-ton cranes, whereby an immediate saving of 80 men was effected. In the wheel shop the common labor force was reduced from 40 to 6 men; the time for reloading a lathe was cut down from 30 to 5 minutes and the total saving in power in that shop was estimated at 50 per cent. In the framing shop the laboring force was reduced 60 per cent. The fuel economy, involving a possible reduction of $120.00 per week, was the smallest item, as the saving in labor was stated at $1,800.00 per week, while the increase in output was large."

This typifies the experience of all iron, steel, bridge and machine shops where the electric current displaces steam.

Pulp and paper plants are equally benefited; so are cotton and textile mills. Typical cotton mills in the Southern States are those at Columbia and Pelzer, S. C., the first using 1,400, the latter 3,000 horse power. At the Pelzer mill the saving in the first cost of shafting and belting, as compared with a similar older plant driven by steam power, reached $10,000, while the increase in the quality and quantity of the output was very marked. One of the New England cotton mills at Taftville, Conn., has been operated for some years with hydro-electric current; two motors of 350 horse power each drive one thousand seven hundred looms, furnish one thousand two hundred incandescent lights, and operate an electric road from the town to the mill and an electric locomotive hauling freight from the steam railway tracks a mile distant.

A marked effect of electric *versus* steam power is reported from the Government printing office at Washington, D. C. At the date of the report of Mr. W. H. Tapley, in 1900, the office had a connected load of 575 electric horse power for printing presses and 125 horse power for elevators. Mr. Tapley reports an increase of 15 per cent. in the output of the press room, and states that during three years, the office running 24 hours daily during Congressional sessions experienced not a single hitch or delay due to trouble with motive power.

Volumes of similar evidence could readily be collected, but the

purpose of this article is to examine specifically the hydro-electric development as a commercial enterprise and to reply to the natural question "will it pay?" by outlining a safe and practical method to find this answer. The first inquiry should always concern the probable application of the output—that is, it should include full investigation of the available market, its proximity to the power source, the amount of power in service, the probable increase by existing plants in response to inducements in price; the cost of power now in use, the hours of service, any conditions favoring location of new industries, and, finally, the sentiment of power users toward the change.

If power is to be obtained for an individual enterprise, this represents the nucleus of the market; in that event, the point is settled to this extent and the search need be extended only as to the marketing of whatever surplus power may remain available, in which case it becomes generally a matter of selecting the most remunerative service first. This discussion will, therefore, treat chiefly of the function of the central plant which, in the large majority of cases, becomes the legitimate and most promising scope of the development.

An available market exists in practically every town of the land, and the opportunity to supply it is almost as universal. Few communities are without industrial plants utilizing power; laundries, printers, barbers, hotels, butchers, saddlers, all have now-a-days power-driven machinery—fans, elevators, pumps. These may appear trivial in the category of market, but on closer investigation will be found to be exceedingly remunerative; in fact, it always is, and rightly should be, the user of the small power unit who pays, and can afford to pay, the best price for the service, as his necessities are too small to warrant individual plants. Wood-working shops of all descriptions use more or less power; the practice of utilizing shavings and cuttings for boiler fuel can readily be shown to be expensive when compared with the cost of electric power; machine shops and iron works of all kinds must employ power, and so do knife, scissor, corset, knitting, shoe, textile, woolen, paper, carriage, flour and grist mills and all other manufacturing establishments. And then there are the public service plants, water works, street and domestic lighting, and traction.

The first step to be taken is to ascertain what establishments are using power and the amount and hours of service, which, when tabulated, will represent the existing available market and the load factor. This latter is one of the most important features of market conditions; the total power used may, for instance, amount to

1,000 horse power, but its distribution throughout the 24-hour day may show that only half of this is in actual service at any one time, and that perhaps 500 horse power would supply all the power used. The daily required output would be $500 \times 24 = 12{,}000$ horse-power hours, but the actual power used may only be 9,000 horse-power hours, in which case the daily load factor is $9{,}000 \div 12{,}000$, or 75 per cent. This investigation may be extended to the yearly output, which for this market would be $500 \times 24 \times 308 = 3{,}696{,}000$ horse-power hours, Sundays and holidays being excluded, while the power used may amount to only 2,217,600 horse-power hours, representing an annual load factor of 60 per cent.

The importance of this market investigation is at once apparent, applying as forcibly to the planning of a power plant as it does to any other commercial enterprise which purposes to supply a certain demand. No set of business men would entertain the building and equipment of a shop or mill for an output twice as large as the apparent demand or market; the consideration of the probable increase of the market is, of course, another matter and, within conservative limits, applies to power plants as it does to other industries.

The next important step, after market conditions are known, is to gain all reasonable assurance of securing the whole of it, or whatever portion can be obtained; to this end power consumers must be conferred with, and if they are operating steam plants, they will generally at first belittle the advantages of changing to electric power; most frequently it is claimed by them that their power is very economical, that they cannot afford to put their steam plants out of commission; many have to use steam for heating purposes and it is difficult to convince them at first that even then the amount saved on power cost will more than cover the expense of steam heat, while they will secure the many other benefits which come to their establishments with electric power substituted for steam. In addition to negotiating with private consumers the public-service opportunities must be dealt with by securing franchises to do business in the town, to set poles and to carry electric lines and, finally, to contract with the town for the lighting and pumping power service.

Having ascertained the amount of power which can be marketed, the price which can be obtained for it should be determined. Broadly speaking, electric power is worth as much as steam power, as even then the consumer secures many advantages which represent savings, such as cleanliness, safety, independent shop and machinery arrangement, speeding of tools, increased output, etc.

A searching investigation of the cost of steam power has recently been carried on in Ontario in connection with the work of a hydro-electric commission organized for the purpose of perfecting a plan of furnishing hydro-electric power by Government aid to the communities of that Province. Aided by the Government machinery, the experts enjoyed rare opportunities to secure authentic data concerning this subject, and the findings are especially pertinent to this discussion. I quote from the Commission's third report, rendered September, 1906:

> "In order to institute a comparison between the cost of electric power and the cost of power generated by steam, the following table has been compiled after a careful study of data available in technical journals, and also from data collected by the Commission's engineers in various towns within the district under consideration. The capital costs have been compiled from information supplied by various makers of engines and other machinery. The table represents average working conditions and assumes a high-class installation."

STEAM-POWER PLANTS.

SHOWING CAPITAL COSTS OF PLANTS INSTALLED AND ANNUAL COSTS OF POWER PER BRAKE HORSE-POWER.

Size of Plant, H.P.	Engines, Boilers, etc., Installed.	Capital Cost of Plant per Horse Power Installed. Buildings.	Total.	Annual Cost of 10-hour Power per B.H.P.	Annual Cost of 24-hour Power per B.H.P.
CLASS I. Engines: Simple, Slide-Valve, Non-Condensing. Boilers: Return-Tubular.					
10	$66.00	$40.00	$106.00	$91.16	$180.76
20	56.00	37.00	93.00	76.31	151.48
30	48.70	35.00	83.70	66.46	131.68
40	44.75	33.50	78.25	59.49	117.74
50	43.00	31.00	74.00	53.95	106.46
CLASS II. Engines: Simple, Corliss, Non-Condensing. Boilers: Return-Tubular.					
30	$70.70	$35.00	$105.70	$61.14	$117.70
40	62.85	33.50	96.35	55.50	107.10
50	59.00	31.00	90.00	50.70	97.73
60	56.00	30.00	86.70	47.42	91.34
80	50.00	27.50	77.50	43.86	85.41
100	44.60	25.00	69.60	40.55	79.19
CLASS III. Engines: Compound, Corliss, Condensing. Boilers: Return-Tubular with Reserve Capacity.					
100	$63.40	$28.00	$91.40	$33.18	$60.05
150	53.70	24.00	77.70	29.83	54.63
200	50.10	20.00	70.10	28.14	51.72
300	45.90	18.00	63.90	26.27	48.83
400	43.55	16.00	59.55	24.84	46.12
500	41.25	14.00	55.25	23.73	44.21
750	40.50	13.00	53.50	23.56	44.02
1,000	39.00	12.00	51.00	23.26	43.71

NOTE. Annual costs include interest at 5 per cent., depreciation and repairs on plant, oil and waste, labor and fuel (coal at $4.00 per ton). Brake horse power is the mechanical power at engine shaft.

SHOWING THE EFFECT OF THE ANNUAL COST OF POWER BY A VARIATION IN THE PRICE OF COAL OF ONE-HALF DOLLAR PER TON.

Size of Plant, H.P.	Steam.	10-hour.	24-hour.
10	Simple	$6.14	$13.47
20	Slide-Valve	5.25	11.56
30	Engine.	4.71	10.35
40		3.56	7.84
50	Simple	3.37	7.41
60	Automatic	3.26	7.16
80	Non-Condensing.	3.15	6.97
100		3.12	6.87
150		1.75	3.85
200	Compound	1.69	3.71
300	Condensing.	1.62	3.60
400		1.56	3.44
500	Compound	1.39	3.05
750	Condensing;	1.39	3.05
1,000	Water-Tube Boilers.	1.39	3.05

This, it will be noted, quotes the cost of brake horse power at engine shaft, which must be transposed into effective working power by allowing for the loss in mechanical drives, and even then the price is representative only for a 100-per cent. load factor.

In units up to 50 horse power with 10-hour service the cost with $2.50 fuel is rarely less than 5 cents per horse-power hour, and generally much higher; the output of plants of 50 to 100 horse power may be 4 cents, and of larger installations of high efficiency from that down to 2 cents per horse-power hour.

For 10-hour service on a fluctuating load the value of electric current in a market of favorable steam-power conditions is from $25.00 to $40.00, depending on constancy of load and maximum demand, while that for 24-hour service is from $35.00 to $50.00, governed by similar conditions. The most serious power competition is found in markets where natural gas is available for fuel, when steam-power output of 250 horse-power units may be reduced in cost to 1½ or even 1 cent per horse-power hour.

After the available market has thus been thoroughly analyzed the investigation of the power opportunity itself may be taken up, along such general lines as will establish the reliability of rights and privileges, the available output, and the cost of developing and delivering this at the market.

In order to secure control of a power site, options are obtained on such lands as include a favorable location for plant and, if necessary, of the flowage right above it. The Federal Government exercises control of all navigable waters, which include most of the large rivers, and permits or licenses must be obtained from the United States War Department to enter upon such rivers for purpose of

development. The policy of the United States Government is distinctly favorable toward the commercial exploitation of these resources, exacting only such reasonable control and supervision as the larger interests of navigation demand. An application addressed to the United States engineer officer in charge of the district, setting forth the purpose and program, will generally secure the privilege asked for. In many sections the county and State authorities exercise some control over erection of dams, requiring the filing of plans and compliance with laws regulating the lumber interests and the protection of fish. The riparian owner can enjoy only the use of the water without retarding, diminishing or diverting the same from its natural channels to the detriment or loss of any other riparian owner or of the State. These limitations of statutes, and the titles to the lands required, deserve competent legal examination before the project of development receives serious consideration.

In many of the States laws have been enacted extending to water-power developments the rights of "eminent domain," by which flowage lands can be acquired on valuations fixed by legally constituted boards of arbitration, but it is most generally preferable and feasible to obtain the flowage easements without title to such lands as will form part of the pond above the development site. The lands required for the works proper should be owned in fee.

After these proprietary conditions have been established the physical examination of the water power *per se* should be undertaken. It is essential to ascertain the amount of available power, the feasibility of harnessing it economically, and the cost of doing so.

The investigations, up to this point, have rather been of the character of generalities, each of them within the scope of the well informed business man's abilities, but at this stage it will be most prudent to select the proper man for the business, that is the engineer.

The first report on the feasibility of development—the available output and its cost—should be made by an expert, a specialist in hydro-electric power engineering. The land surveyor can competently run the levels and ascertain the fall, the experienced civil engineer design a dam and canal, the hydraulic engineer measure the flow and design pressure lines and perhaps turbines, and the electrical engineer the generators and transmission line; but none of these is equipped to compass the entire subject, which is strictly the field of the engineer who devotes himself largely to the study and practice of the combined branches entering into this subject, which is rapidly becoming a specialty. Upon this report, and upon the conclusions arrived at as to market conditions, the project is to be financed; it

is, therefore, this first report which is, beyond all doubt, the most important link in the chain.

To find the available flow, so-called—that is, the supply which may be safely accepted as the basis for the output that may be contracted for—is perhaps the foremost of the many important facts to be covered in this report, and, at the same time, the one which is most frequently in error.

The determination of available flow cannot be based upon a measurement or two; on the contrary, all the characteristics and conditions which influence stream flow must be investigated in order to secure an adequate knowledge of its fluctuations. A period of ten or fifteen years should be studied, the monthly and annual precipitation during this period in the drainage area under consideration should be ascertained, and from these data the dry, normal, and wet year and the corresponding flow determined. How this question is solvable will appear in the next article.

When these data are graphically projected and analyzed the otherwise bewildering conditions will appear as an open book, even to the layman, disclosing the periods, duration, and repetition of low, normal, and high flow, and point to the sought-for standard.

Hydro-electric developments should no more be based on the low than on the high flow, but on some stage between the low and normal in which the deficiency of the former can economically be raised to the highest point in the latter, by means of supply from storage or by auxiliary plant, to such an extent, measured by cost, as the value of the output in the available market will warrant.

Even at the risk of frequent repetition it must be pointed out that this individual point—the determination of the flow to be accepted as a basis for the development—is the keystone of the structure, and that the solution of the problem lies not within the scope of the dilettante at this business. Over-estimation of the flow is responsible, more frequently than any other cause, for the commercial miscarriage of hydro-electric projects. The fact that they appear to be based upon what is very generally, though erroneously, considered an unreliable factor is among the chief reasons why this class of enterprises does not as readily command the confidence of business men as others. When hydro-electric propositions receive the competent consideration which is generally secured for industrial undertakings there is no such uncertainty; and, when endorsed by authorities on the subject, they represent invariably most satisfactory investments.

Next to market and output comes the determination of the cost. For this purpose the character of the development, type of structures,

power units, generating and transmission equipment, all must be fixed upon; the works must be designed and estimates made of the cost of each construction and equipment feature. It is needless to state that the designer of such a plant must be experienced in this line of work; every situation calls for its own peculiarly fitting development program, and the structural types of works are to be largely determined by local conditions of topography, geology, available materials, transportation, climatic data and a number of other influential conditions. No two such plants are exactly alike if treated most economically for the best results. Which is the most advantageous dam location; whether the available head shall be accumulated at one point or whether a portion of it may be secured more economically by diversion to a lower site; what type of dam is the most suitable; whether the water shall be carried to the turbines by canal, flume, or pipe; what is the best location for the power station; how the turbines shall be placed, whether in open penstocks or in cases; whether horizontal or vertical installations will give the best service; what are the proper units as to capacity and speed—these are only a few of the problems to be solved by the designer of such a plant, and even the merest tyro at this business will readily appreciate that between the right and wrong on any of these subjects there is probably a matter of thousands of dollars saved or wasted—if, indeed, a mistake does not perchance involve the ultimate practicable success of the entire project.

For instance, the choice of the type of dam, generally one of the costliest parts of the plant and largely its chief reliance for safety, certainly calls for broad experience. For want of this and of original resourcefulness, the massive, solid masonry dam still holds almost absolute sway, though the most costly type and difficult of proper construction. To resist water pressures by weight of mass is, however, not the only solution of the problem, nor the most economical one, as the modern development of concrete-steel and its application renders it practical to sustain safely any pressures by comparatively light structures so designed that the weight of the very material which threatens its safety is utilized to counteract this destructive force. But it is not the purpose to treat of the engineering phase in this article; that subject will receive special attention in the future; suffice it to say that what has been here pointed out as to one part of a hydro-electric plant is true of all the numerous features, from the dam to the sub-station of the transmission line at the point of delivery.

When the cost of the output has been established, it should show that of the physical works by which the hydraulic energy is concen-

trated for conversion into mechanical work, of the generating equipment, and finally, of the transmission plant. The output should be expressed in electrical units, as that will be its commercial measure, and, in its determination, the efficiencies of turbines, generators, transformers, and transmission lines should be taken at their practical working values, rather than at such ratios as are found in trade catalogues or are even frequently expressed as guaranteed in specifications. Carelessness in this regard will easily result in showing an output 10 or 15 per cent. in excess of the actual, and very frequently such percentage represents the determining margin for a safe or unsafe enterprise. Nor should the cost estimate fail to add the contractor's profit and a liberal allowance for engineering and emergencies.

And now the project may be analyzed as to its commercial value. The capital investment required is known; the fixed charges will consist of interest on this, making proper allowance for the shrinkage of debentures from face value; the sinking fund providing for serial retirement of bonds; the operating cost of generating, transmission, and distribution plant; the cost of maintenance, and the charge for depreciation of works and equipment, taxes and insurance. To offset the total of these is the receipt from current service. This is now a purely commercial problem and, if the old saying "that figures do not lie," could be taken for gospel truth, the conclusion would be infallibly correct; but *be sure that these figures are right or on the right side of error;* that is ever conservative.

The casual reader may have arrived here with an impression that the correct analysis of a hydro-electric project is somewhat of a rare feat, but be it far from my purpose to leave it at that; it is merely a case of the correct reading of the symptoms, which is much more practicable in a hydro-electric development than in determining the value of a mining proposition, of a railroad project, or of many other enterprises which are accepted with no lack of faith when "O. K.'d" by recognized authority. Why not also with the hydro-electric project? Merely because of its much more recent advent, in the sense of an important branch of enterprise, and because the authorities competent to pass upon it correctly are not so many nor so well-known as in the much older lines.

The succeeding article describes and illustrates some plants recently constructed representative of modern practice and a few undeveloped opportunities typical of many awaiting utilization. The series will be closed with an article treating of hydro-electric engineering presented from the commercial and industrial point of view.

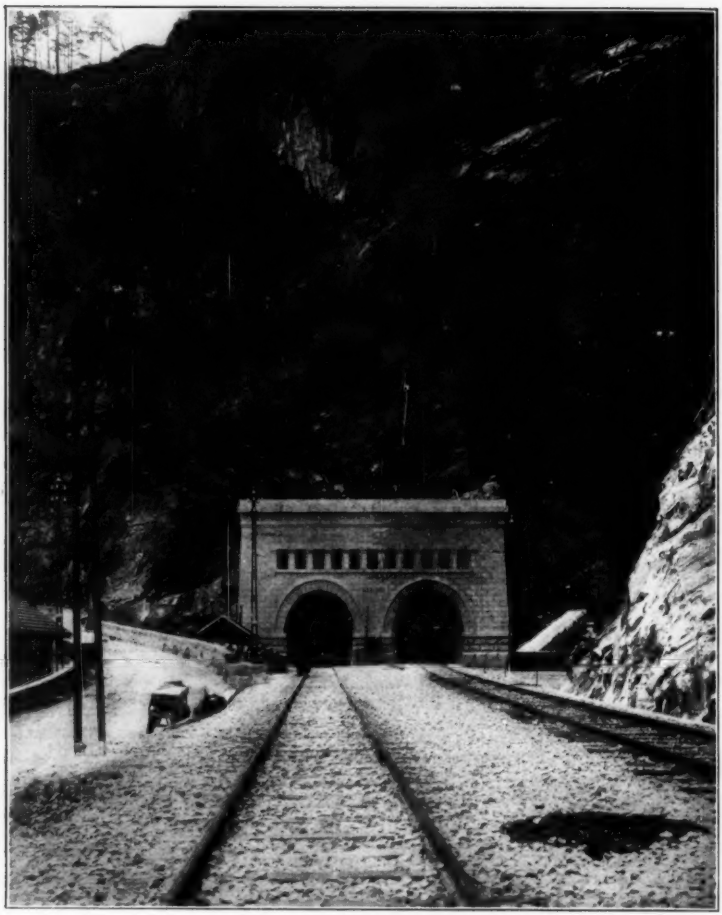
ELECTRIC TRACTION IN THE SIMPLON RAILWAY TUNNEL.

By J. B. van Brussel.

FOR several years past, even before the Swiss Federal Railways decided to adopt electric traction in the Simplon tunnel, most Continental manufacturers of electrical material had been giving this subject their most careful attention. The advantages of electric driving for tunnel haulage were evident; and one alone—the absence of smoke—is of such importance in lessening the great difficulty of satisfactorily ventilating a tunnel of great length, as to ensure the adoption of an electrical method of working, particularly as such great progress had been made recently in adapting electric traction to main-line railway work. It was felt that there was not the slightest risk in applying this system of working upon the most important main lines.

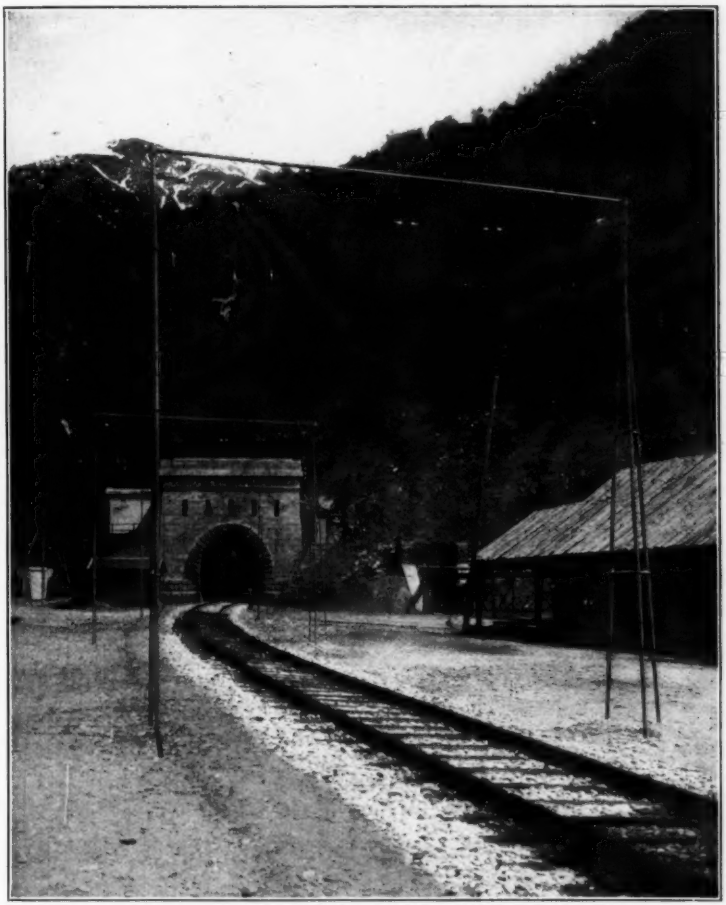
In Autumn 1905, Messrs. Brown Boveri & Co., the well-known Baden firm, made an offer to the Federal Railways to instal a system of electric traction in the Simplon, undertaking at the same time to have the work completed in time for the opening of the tunnel—that is to say, by a date which would correspond approximately to the opening of the International Exhibition of Milan. They offered to put the whole of this installation at the disposal of the Federal Railways so that a comparison could be made on a large scale between steam traction and electric traction. In the present case this comparison is of particular interest owing to the sections and general conditions of working of the Simplon line.

After having hesitated for about two months, as to the reply to be given, the Federal Railways authorities accepted the proposal, but on conditions which were somewhat onerous from the contractors' standpoint, as a clause in the contract stated that the authorities had power to abandon the system at the end of a year, and to call on the contractors to remove the equipment, if unsatisfactory results were obtained. Further, the contracting firm was required to have the electric equipment ready by June 1st, 1906. This acceptance took place at the end of the year 1905, so that a very short time only was



THE ISELLE ENTRANCE TO THE TUNNEL.

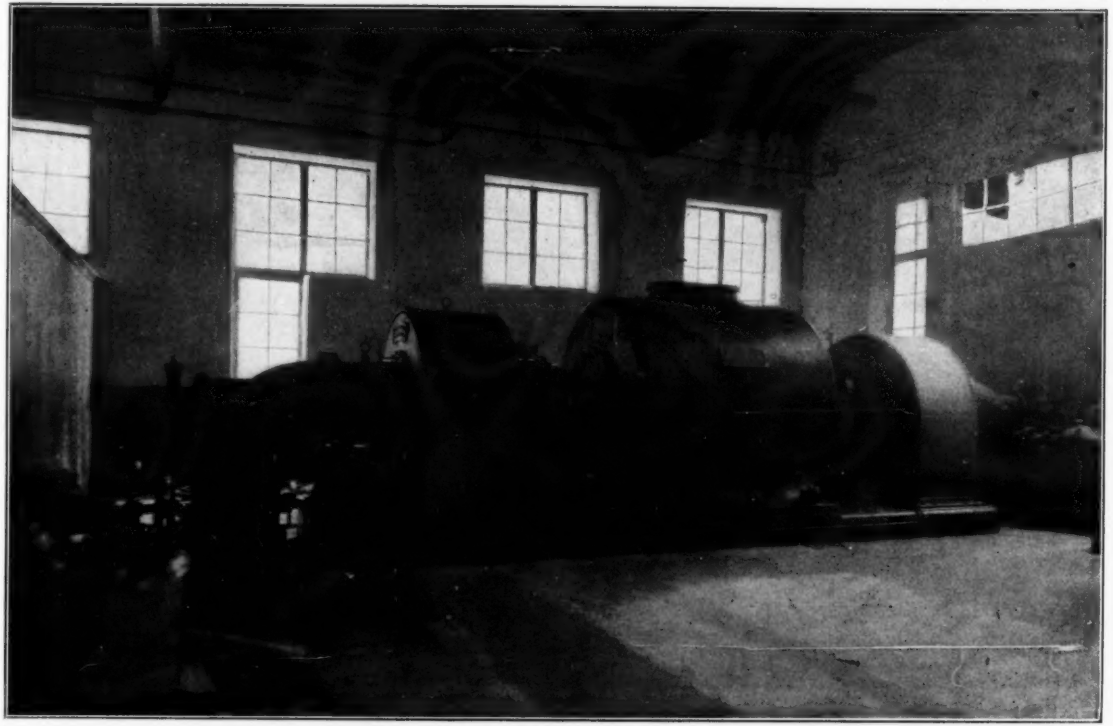
given for the fulfilment of the undertaking. For this reason the contractors selected that system with which they had had the greatest experience at that date, namely the three-phase system. As they had at that time two three-phase locomotives of 1,000 horse power in course of construction for the Adriatic Railways (Valtellina line), it was proposed (in order to gain time) to make use of these in the Simplon tunnel, and the matter was brought before the Italian Rail-



THE ENTRANCE TO THE TUNNEL AT BRIGUE.

way Company, who readily gave their consent to this, and moreover consented to put at the disposal of the contractors three additional locomotives of the Ganz type, to provide sufficient motive power for passenger and freight traffic.

Owing to the short time available for completion it was thought better to make use of existing sources of power supply wherever possible. The two water-power stations at Brigue and Iselle, which



WATER TURBINES AND ELECTRIC GENERATOR IN THE ISELLE POWER PLANT.

had supplied power for the many machines used in boring the tunnel, were somewhat modified and converted into temporary generating stations for the supply of the necessary current. Later on one large power house will be constructed, replacing these two stations, which are already somewhat out of date, and not as reliable in operation as could be desired.

The current is generated at a pressure of 3,300 volts and a periodicity of 16 cycles. This is perfectly suitable for direct supply to the motors without the use of intermediate transformers. In the central station at Brigue (Switzerland) there is one three-phase alternator rated at 1,200 horse power at 160 revolutions, but capable of supplying temporary overloads up to 1,500 horse power. It is driven from a main transmission shaft, which is itself driven by two Escher-Wyss turbines each of 600 horse power; the fall is 146 feet. The alternator is excited from a 95-horse-power dynamo which was part of the original plant. The Escher-Wyss turbine was not at that time fitted with an automatic regulator, and it was therefore necessary, in order to keep a constant speed, to use in the generator circuit a water resistance of such capacity that it could absorb, if necessary, the whole of the energy given out by the alternator. An automatic regulator is provided to adjust the capacity of the water resistance in accordance with the load on the line, so that the alternator is kept always fully loaded, and there is no risk of any serious variation of speed.

All the necessary measuring instruments and apparatus for controlling the circuits are mounted upon one switchboard, from which connections are carried to the overhead conductors and the rails, by means of overhead wires.

In the central station at Iselle (Italy), which is the old pumping station, there is one three-phase alternator rated at 1,500 horse power. It is direct-coupled to a double-ended turbine, each of the turbine units being capable of developing 750 horse power. The set runs at 960 revolutions with a fall of 460 feet and is fitted with a sensitive governor which keeps the speed nearly constant. This set can be overloaded up to 1,800 horse power and even more. The excitation current is taken from a continuous-current machine of 95 horse power and 125 volts, which was formerly used in the tunnelling operations. The switchgear is similar to that employed at Brigue.

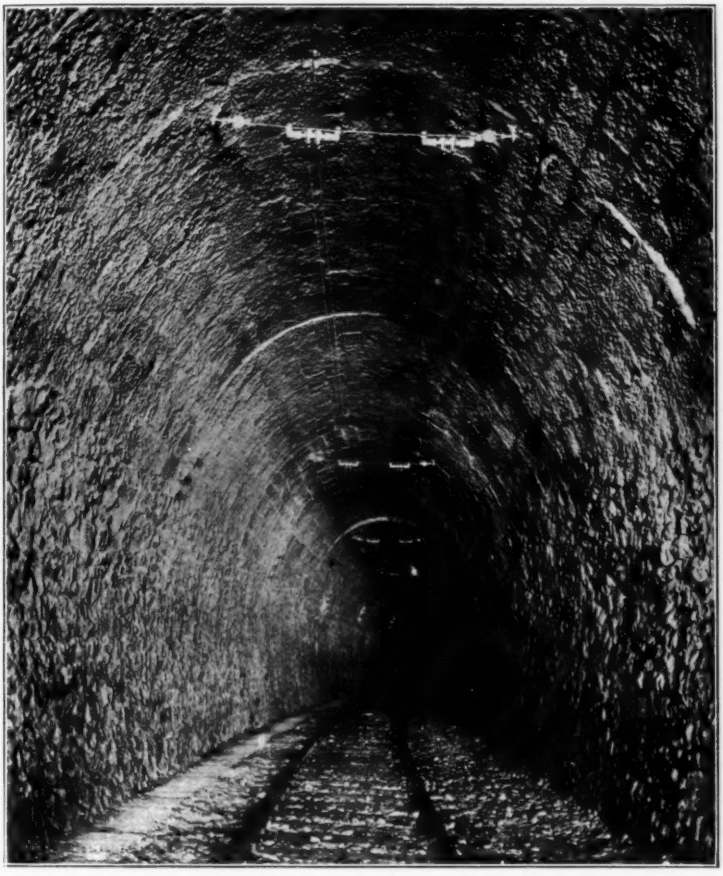
As to the line, two of the phases are overhead conductors, the rails being the third conductor. The whole line is divided into five sections, as follows: 1, from the station at Brigue to the northern

end of the tunnel; 2, northern half of the tunnel; 3, crossing in the middle of the tunnel; 4, southern half of the tunnel; 5, from the southern end of the tunnel to the Iselle station. Section switches are provided at Brigue, at Iselle, and at the station in the middle of the tunnel, and telephonic communication is provided for transmitting orders to the operating staff in charge of the switches.

SUSPENSION OF AERIAL CONDUCTORS ACROSS A NUMBER OF TRACKS.

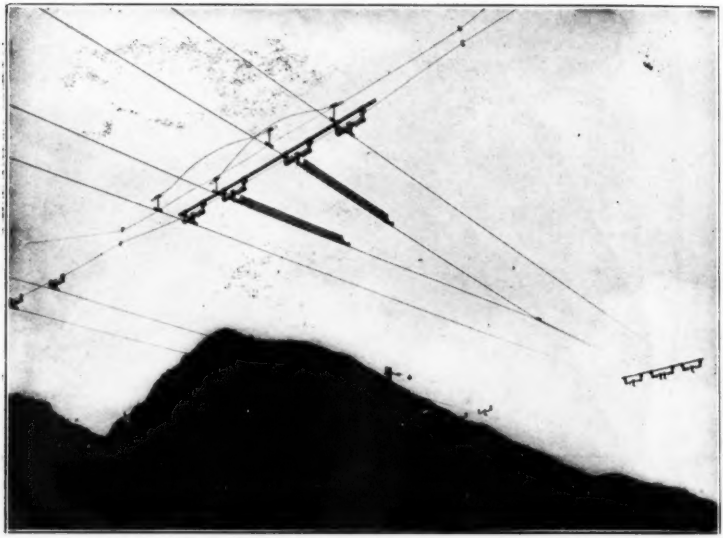
Outside the tunnel the overhead line is suspended on cross wires strained between steel poles which are placed on either side of the track. At Brigue there is a separate set of poles for each track, so that the whole construction is exceedingly solid, and further work can be carried out on one of the lines without affecting the other. At Iselle, on the contrary, this construction could not be employed, as the tracks are too near to one another to allow of poles between them. A very long cross wire is used, and the poles are placed on each side of the line and a catenary type of suspension is employed.

In the tunnel itself the conductors are carried on cross wires which go from one side to the other and are fixed by means of gun-metal bolts cemented directly into the face of the tunnel. These cross suspensions have been kept as simple as possible, and in order to give them maximum stiffness a single wire has been used, without any



INTERIOR OF TUNNEL, SHOWING MODE OF TROLLEY-WIRE SUSPENSION.

strain insulators, which would only have had the effect of weakening the suspensions. The suspension wires are fixed quite simply at each end to a porcelain insulator, arranged so that the wire may be drawn as tight as required. They are spaced about 83 feet apart on the straight portions of the line, and about 42 feet on the curves. It has not been found necessary to put them closer together than this, as the temperature in the tunnel is practically constant and the conductors can be strained very tightly, so that the sag is quite small even for a length of 80 feet or more.



SUSPENSION OF AN AERIAL CONDUCTOR.

In order to keep down the pressure drop in the tunnel, the total length of which is some 12½ miles, and as it was not considered advisable to use transformers there, conductors of a somewhat larger section have been used than were employed outside the tunnel, where the conductors are of .078 square-inch section per pole, being .315 inch diameter. It was decided to use two wires per pole, each of a similar section, in preference to using one wire of larger diameter, for the following reasons:—

1. The diameter of .315 inch is the largest in general use for overhead contact lines, and, further, there is a much better chance of getting thoroughly homogeneous and hard wires.

2. The smaller wires are far more easy to handle.

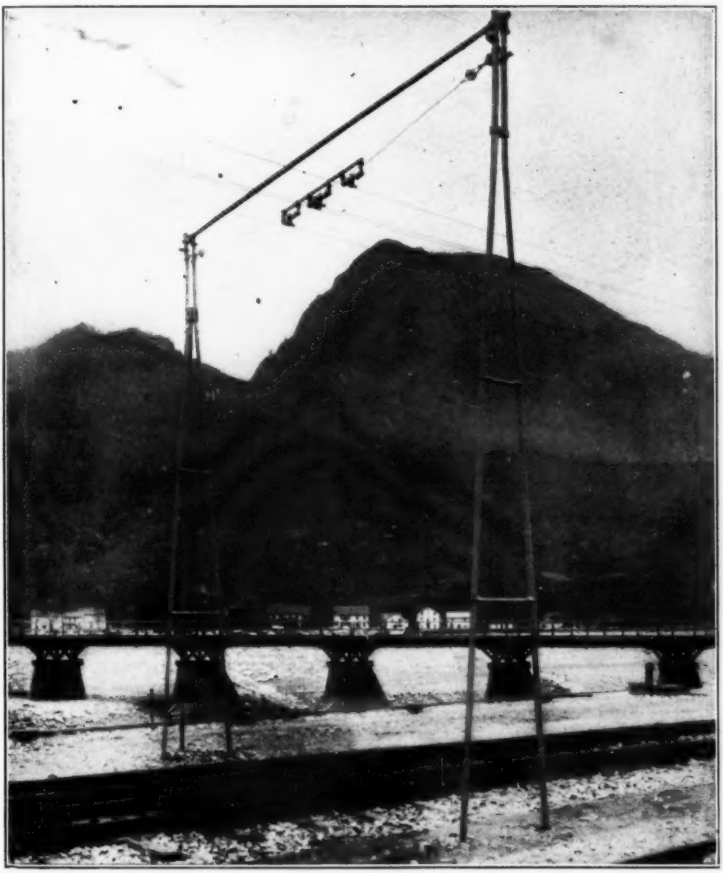
3. The fact of having two wires per pole ensures far better contact surface on the bow collectors.

Over and above these advantages, the supply is not interrupted if one of the wires breaks, for current can still be supplied by the second conductor until pressure can be taken off the line and the damaged conductor replaced.

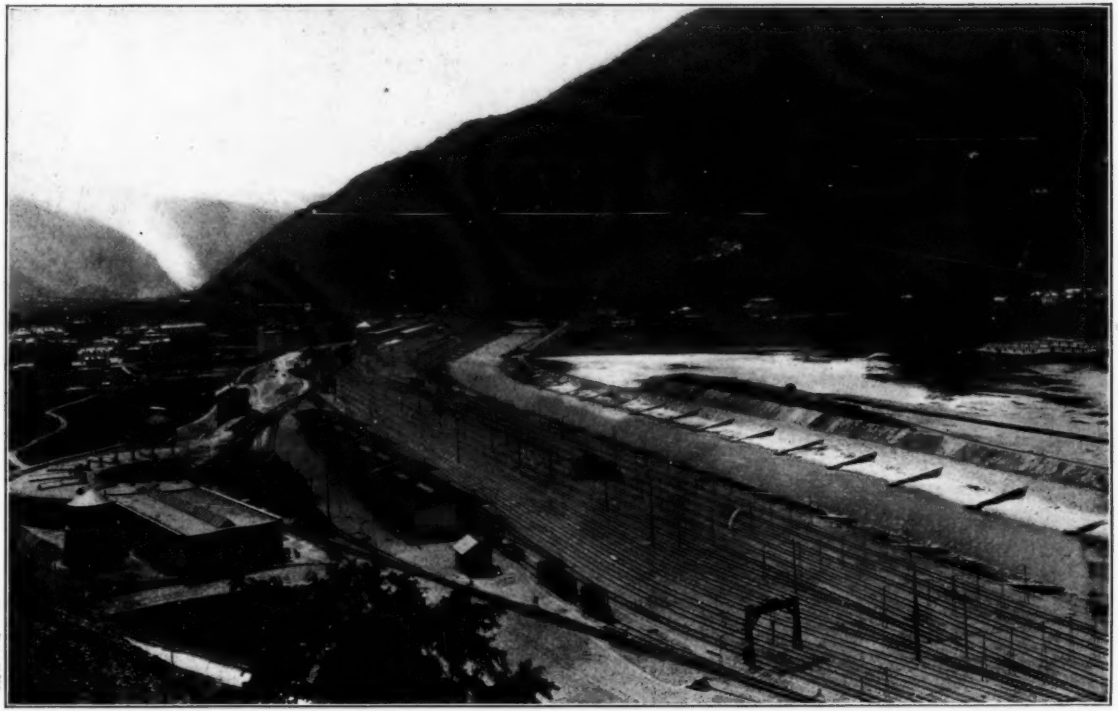
The conductors are carried on the cross wires by means of a special type of insulator. Double insulation is employed in ebonite

and porcelain, so as to make certain of good insulation under all conditions, however unfavourable as regards temperature, moisture, etc. These insulators are constructed of a piece of ebonite in the form of a bolt, to which the conductor is suspended. This bolt is carried in a cross piece of gun metal fixed at its two ends in strong porcelain insulators by means of hemp and asbestos. These insulators are carried in gun-metal pieces by means of which the complete insulating block is suspended from the cross wire.

This system of insulating is thoroughly reliable, for even if one of



STANDARD BENT FOR SUPPORTING TROLLEY WIRE.



TRACKS AND OVERHEAD CONDUCTORS AT THE BRIGUE ENTRANCE TO THE TUNNEL.

the insulators is defective the other will be amply sufficient to prevent leakage and to allow of temporary working of the service until a suitable opportunity occurs for repair. These repairs can be carried out exceedingly quickly as all parts of the insulator can be separately replaced.

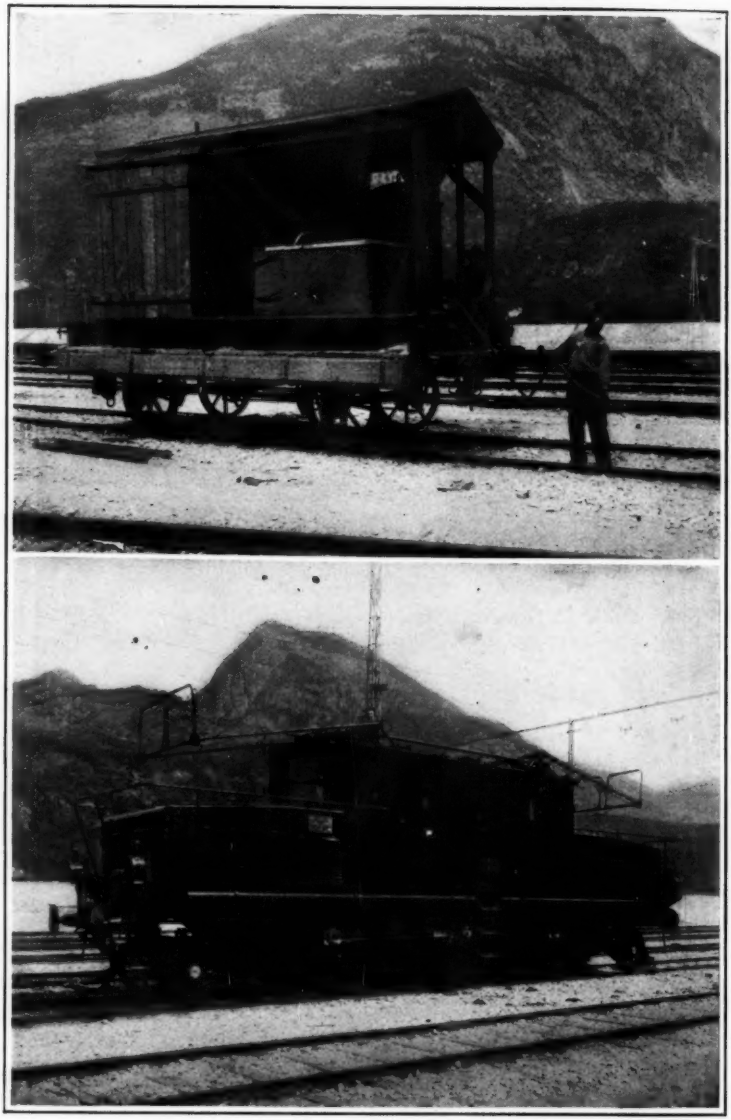
Periodic inspections are carried out on all the insulators, each of which is tested with a pressure of 18,000 volts. Each separate insulator, whether of ebonite or porcelain, is tested separately at 10,000 volts, so that the complete insulating block will stand a pressure of from 30,000 to 40,000 volts, which is far more than necessary for a working pressure of 3,300 volts, even under the most unfavourable atmospheric conditions.

In order to equalise the wear of the bows as much as possible, the overhead conductors are not kept parallel to the rails but are arranged in zigzag fashion on the cross wires.

As has been mentioned the rails themselves form the third conductor, and these are bonded in accordance with a system by which ordinary fishplates only are used to conduct the current from one rail to the next, and no special splices or copper connections are employed. In making this electrical joint the first thing to do is to clean thoroughly all the joints through which the current will pass. This is done by means of a sand blast specially constructed for the purpose. When these joints are once absolutely smooth, they are covered with a thin layer of patent paste, the object of which is to prevent absolutely any oxidation of the contact surfaces. The fishplates are then bolted up in the usual manner to the rails and a thoroughly good and lasting connection is made. The system is an exceptionally simple one, and has given satisfactory results where it has been used.

The locomotives securing the service are of the bogie type, with five axles, of which three are driven by the motors. The traction motors are placed between the three pairs of driving wheels, and both drive on the middle axle by means of a bar coupling them rigidly together. This axle in turn drives the other two by means of a coupling rod so that there are no gears. It appeared preferable not to key the motors onto the axles themselves, as the dismounting in this case would be much more difficult.

The locomotives are built on liberal lines. When starting at the higher speed with a passenger train weighing 300 tons, a draw-bar pull of 16,600 pounds is required in order to obtain the specified acceleration of 0.5 feet per second, and when starting at the lower speed with a goods train weighing 400 tons a draw-bar pull of 20,000



ONE OF THE THREE-PHASE ELECTRIC LOCOMOTIVES, AND THE RAIL-BONDING CAR.

pounds is required to obtain the specified acceleration of 0.36 feet per second.

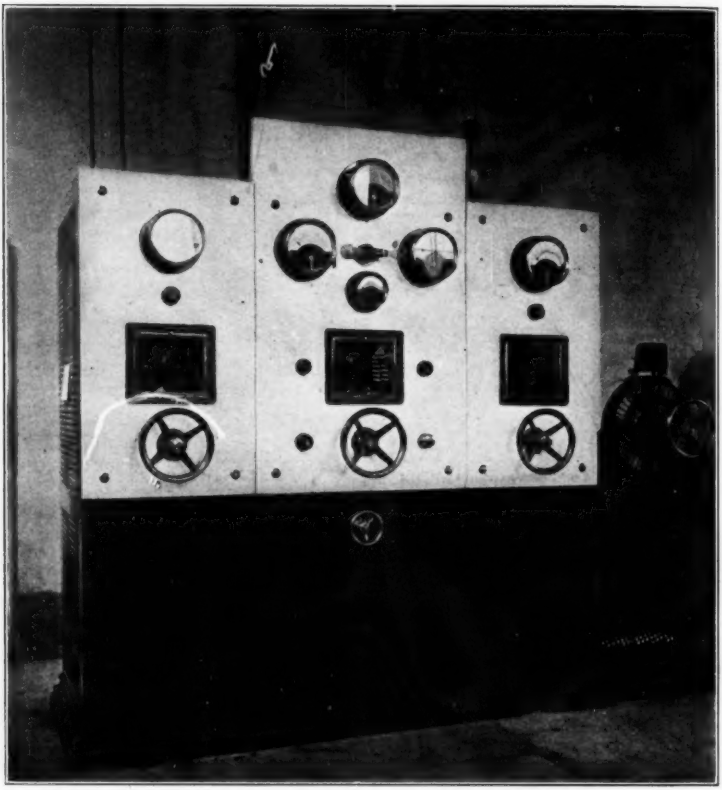
The following are the leading dimensions of these locomotives:

Length between buffers, 40 ft. 6 in.
Total length between axles, 31 ft. 10 in.
Distance between driving axles, 16 ft. 1 in.
Distance between bogies, 23 ft.
Diameter of driving wheels, 5 ft. 4½ in.
Diameter of smaller wheels, 2 ft. 9½ in.
Weight on the driving wheels, 42 tons.
Weight of the mechanical portion of the equipment, 34 tons.
Weight of the electrical portion, 28 tons.
Total weight, 62 tons.
Normal output of the two motors together, 900 h. p.
Maximum output of the two motors together, 2,300 h. p.
Weight of the motor complete, 10¾ tons.
Normal speeds, 42 miles and 21 miles per hour.
Draw bar pull at 42 miles per hour, 7,700 lb. normal, and 20,000 lb. maximum.
Draw bar at 21 miles per hour, 13,500 lb. normal, and 31,000 lb. maximum.

Air pressure is used for raising and lowering the bows, and for operating the high-tension switches. This air supply is provided by a couple of small electrically-driven compressors, the power for which is obtained from the main trolley-line, through small oil-cooled static transformers rated at 7 kilowatts, and giving current at 110 volts. One of the air-compressors in normal working provides the air necessary for the Westinghouse brake, and the other that for the whistle, the pneumatic sanding appliances, and for operating the high-tension switches. The pumps deliver air into reservoirs placed below the foot-plate, and means are provided by which the current is cut off from the compressors automatically, when the reservoir pressure exceeds 7½ atmospheres, and also automatically started up again, when the pressure falls.

The regular working of the electric trains through the tunnel began, as fixed, on June 1st, 1906. Unexpected difficulties were then quick to declare themselves, the most serious being a failure of the insulation of the new engines, due to the extreme moisture and the heat of the air of the tunnel, which is regularly of about 93 degrees F. These, however, were promptly overcome. On renewing the insulation of the locomotives the air-ducts provided were closed, a procedure which was possible because the trip through the tunnel lasts only 20 to 30 minutes, and the locomotives can easily carry their full load for this length of time without overheating even when the ventilating ducts are stopped as stated.

Some interesting observations on the increase of train resistance on passing through the tunnel have been made. Measurements



SWITCHBOARD IN THE IRICUE POWER STATION.

proved that about 400 horse power more is required to haul a train at 43½ miles per hour through the tunnel than would suffice for it in the open. It was further found that on the 7 per 1,000 gradient from the summit to the Iselle portal the motor would not run down by gravity if alone, but would with a train behind it. The speed, however, never exceeds 33 miles per hour, under these conditions, so that the extra resistance of the tunnel as compared with open track is apparently about 15 pounds per ton, and this although the ventilation is in the direction of the motion. The resistance is slightly greater to motion in the reverse direction, but not very materially so.

PRESENT PRACTICE IN THE USE OF SUPERHEATED STEAM.

By Reginald Pelham Bolton.

III. LOCOMOTIVE AND MARINE APPLICATIONS AND SUPERHEATER DESIGN.

Mr. Bolton's series began in March last with a review of the troubles experienced by the early users of superheat, the most important recent tests and experiments, American and Continental, and the general relations of superheating to economy in the steam cylinder. His second paper took up the variance between American and European practice in the use of high superheat, the use of superheating in steam-heating practice, and the design and construction of piping systems, etc., where high degrees of heat are used. The article now presented concludes the study, and to it is appended a bibliography of the contributions to the subject in Society transactions and the technical press during the past fifteen years, as compiled from the Engineering Index.—THE EDITORS.

IN locomotive practice, the conditions on the face appear to be largely favorable to an economic use of superheat. The high temperature of waste gases, the peculiarly adverse cooling and condensing cylinder conditions, and the close physical relation of gas uptake and cylinders, all lend themselves to adaptations which appear to present no very considerable difficulty comparable with the results attainable.

The practical trials instituted by the Prussian Railway authorities in 1904, and carried out with a set of similar machines, operated over a given section of road, with similar loads, and at 185-pounds working pressure, showed a progressive gain, as follows:

With 50° F. superheat, Water saved, 2.5 per cent.; Coal saved, 2 per cent.
With 104° F. superheat, Water saved, 10 per cent.; Coal saved, 7 per cent.
With 158° F. superheat, Water saved, 16 per cent.; Coal saved, 12 per cent.

The subject is one in which the past record of locomotive engineering in the United States demands the active present interest of that branch of the profession, now so insistently called upon to compete with a method of traction using power distributed from central points. This latter system, cumbered as it is by superior charges for labor, for installation and maintenance, has but one source of advantage over the use of the independent steam locomotive, namely, the superior economy of net power production by enlarged apparatus; and had the methods of locomotive design kept pace with the competitive development of power-station practice, it is probable that less would be heard of long-distance electrical haulage.

Locomotive engineering seems to have been to a great extent a stationary practice since the partial adoption of compound cylinder work, the real economy of which is evidently bound up with the adaptation of superheat, toward which little or no effort has been made.

Marine Practice.

In marine practice, it is regrettable to have to admit that very little advance has been made by American engineers in the past decade. Had the initiative in the matter of turbine development come from the United States, undoubtedly the cognate subject of superheat must have followed and kept pace with it. But patent restrictions surrounding the modernized developments of that very ancient appliance have retarded, until quite recently, the introduction of the turbine in American marine work, and American engineers must feel humbly gratified, therefore, that there are at the present moment some substantial vessels building in American yards in which both turbines and superheaters are adopted.

The huge experiment of the Mauretania, which will soon interest us, and, as will be fully expected, reward those whose splendid faith has brought about her engine construction, will undoubtedly lend a great impetus in this direction to other marine owners and engineers.

One of the most definite, extensive and continued demonstrations of the value of the application of superheated steam to marine work is shown by the record of the steamers of the "Inch" line,—the steamships Inchdune, Inchmarlo, Inchkeith, Incharan and Inchmore, a description of which may illustrate the work capable of accomplishment in this direction.

These are fine freight vessels of 6,000 tons, fitted with quadruple expansion, five-crank engines, one high-pressure, two intermediate, and two low-pressure cylinders; the air, bilge, and feed pumps are driven off the main engines. The two steamers first-named were placed in commission in 1900, and were succeeded by the later vessels.

The working pressure is 267 pounds per square inch, and a superheater, built by the Central Marine Engineering Works, of West Hartlepool, consisting of 168 waved tubes in three sections, is set in the uptakes, just above the upper row of tubes of the two Scotch boilers, each of which is 13 feet in diameter by 10 feet 6 inches long. The arrangement provides for the progressive heating of the steam and progressive cooling of the gases. The steam is superheated from 412 degrees, (the temperature corresponding to a condition of dry saturation at 267 pounds per square inch), to 469.5 degrees, or an ad-

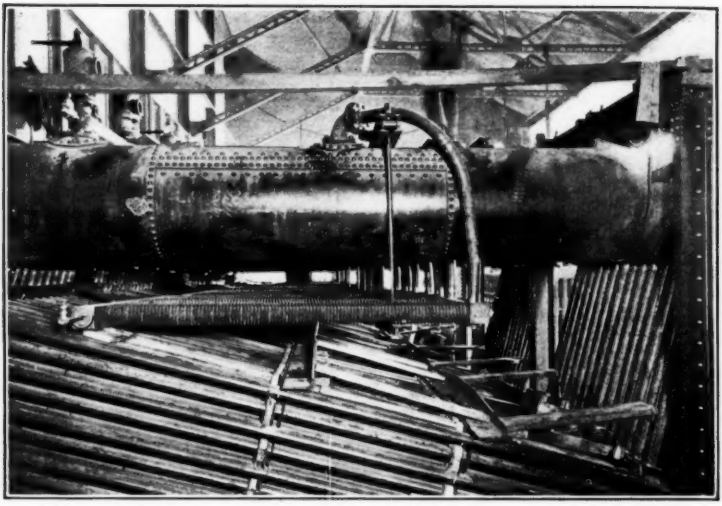
heat of 57½ degrees F. The temperature is maintained in the second receiver, and at the high-pressure steam chest averaged 447 degrees. The work is accomplished by the waste gases, which in addition heat the air for the furnace supply about 250 degrees, or from an outside temperature of 54 degrees to 299 degrees F., the draft being handled on the Ellis and Eaves system.

On a trial, the waste gases below the superheater were at 620 degrees, reduced by the superheater to 543 degrees, and by the air-heating tubes to 404 degrees, the temperature of chimney discharge, showing the very good result of over 33 per cent of the waste heat turned into useful work.

Feed arrangements were good, increasing the hot-well temperature of 96.5 degrees F. to 310 degrees at the boiler feed. With these generally obtaining conditions, on a sea trial of the Inchdune and Inchmona, between West Hartlepool and Dover, the coal consumption was reduced to the extremely low rate of 0.97 pound per indicated horse-power. This excellent result has been practically maintained, for on a very recent visit of the Inchkeith to the port of New York, it was authoritatively ascertained from the owners' representatives that her entire coal consumption over 12 months has not exceeded 1.1 pound of coal per indicated horse power, including, of course, all auxiliaries. This fuel has varied from the best Welsh coal, on out-bound trips, to the poor Bombay slack, on her return runs from Asia.

The fact that these vessels have proven so satisfactory, during five years' service, that successive additions have been made to the fleet of vessels of the same type, and with the same feature of the use of superheat in the steam supply, not only demonstrates the excellence of their construction and design, but also sufficiently defines the economic advantage of superheat and the practicability of its permanent maintenance. Mr. William Bloor, M. E., who was the engineer in charge of the trials, and to whom I am indebted for the details herein given, states further that the diagrams showed an area of 89.7 per cent of the area between highest and lowest pressures, and that comparative diagrams, with saturated steam, showed superiority in area of the superheated vapors as high as 15 per cent.

The economy of operation of these boats is remarkable. At a speed of 9½ knots, a consumption of 1.1 pound works out to only 17 tons per diem, and at an average price of $4.00 per ton, the cost of fuel would be 22 cents per mile, or at 6,170 tons dead weight, one ton is carried 280 miles for a cent.



FOSTER SUPERHEATER, SET IN BABCOCK & WILCOX BOILER, NAVY YARD, WASHINGTON, D. C.

One of a battery of five; there are four such batteries, or twenty units altogether. Working pressure, 200 lb.; superheat, 120 degrees. Power Specialty Co., N. Y.

SUPERHEATERS.

In superheater construction much has been accomplished, and very practical forms have been developed by American engineers. The larger boiler manufacturers have devoted time and expense to the preparation of apparatus capable of desirable application to their particular types of steam generator, and a choice of excellent forms of superheaters, combined with boilers, is now available.

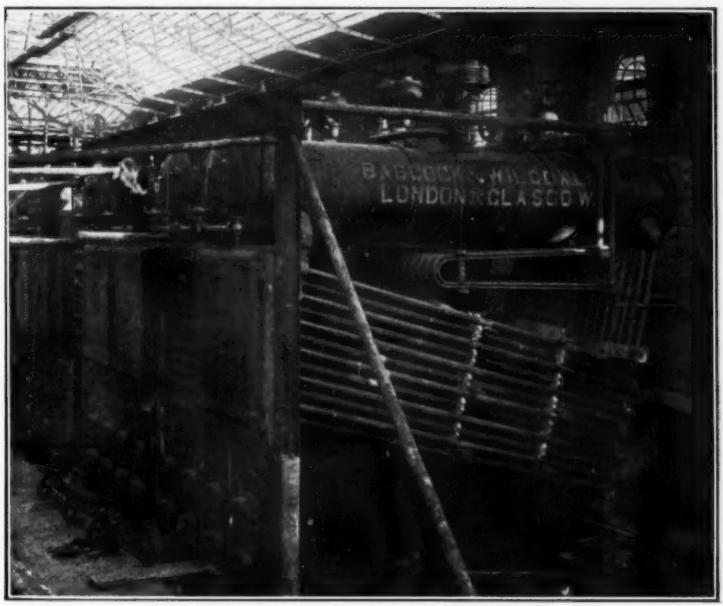
The pioneer work of Mr. E. H. Foster, M. E., in this matter, must not pass unrecognized, as there can be no doubt that to his persistent advocacy of the practicability of the system of combined (as well as of separate) superheating apparatus, much of the present extent of such installations is due. His paper on this subject, read in 1901 before the American Society of Mechanical Engineers at Milwaukee, formed a striking re-statement of the case for superheat, which drew wider attention to the subject, and made the second half of the decade which we have been considering a more active period in this direction than the prior portion.

The many forms of superheat generators, chiefly German, evolved, by a tedious process of elimination, the general types of superheaters of today, which may be divided into two main classifications, viz:

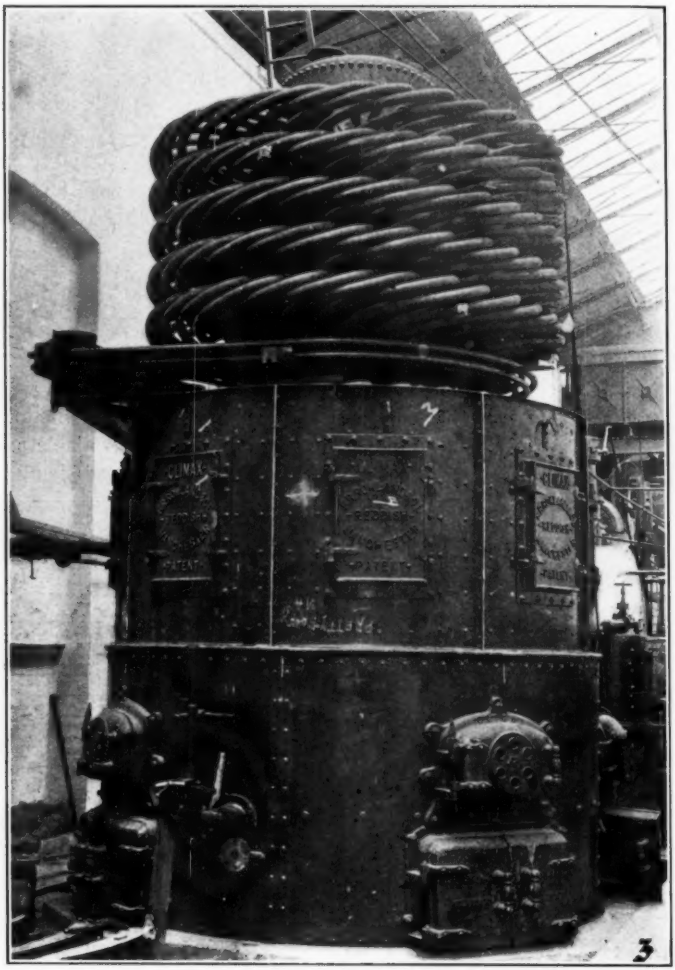
those contained with and forming part of the boiler and flue combination, and those separately fired, with the further detail difference of wrought or cast materials in their construction.

Into the merits of the two forms of super-heater—the independent, and that combined with the flue system of the boiler—I cannot here enter, save to say that undoubtedly each has its proper place, and each should always receive due consideration in any well-developed design of steam plant. A number of German and other devices and methods are illustrated in the paper by George Hutchinson, Vol. XXII., Transactions American Society Mechanical Engineers, which may be studied to advantage.

It has been at this point of the advance of the practical provisions for superheat that American engineering took up with any degree of interest the construction and adaptation of the appliances, in which line excellent results have been so far accomplished with moderate degrees of added heat. While some data are already available as to the desirable and effective relation between gas and steam tempera-



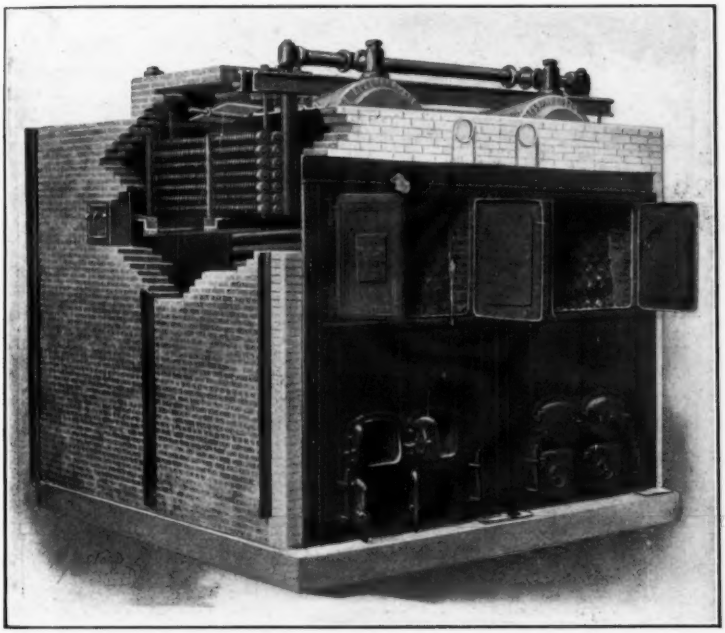
BABCOCK & WILCOX SUPERHEATERS AND BOILERS, SOUTH DOCK, CARDIFF, WALES. Five boilers of 4,780 sq. ft. heating surface each, fitted with superheaters each having 452 sq. ft. heating surface, capable of imparting 100 degrees superheat to the steam. Babcock & Wilcox, Ltd., Renfrew.



SUPERHEATER APPLIED TO CLIMAX WATER-TUBE BOILER.
B. R. Rowland & Co., Ltd., Reddish, Manchester.

tures, further observation and study will undoubtedly be repaid and a wide field for further developments exists.

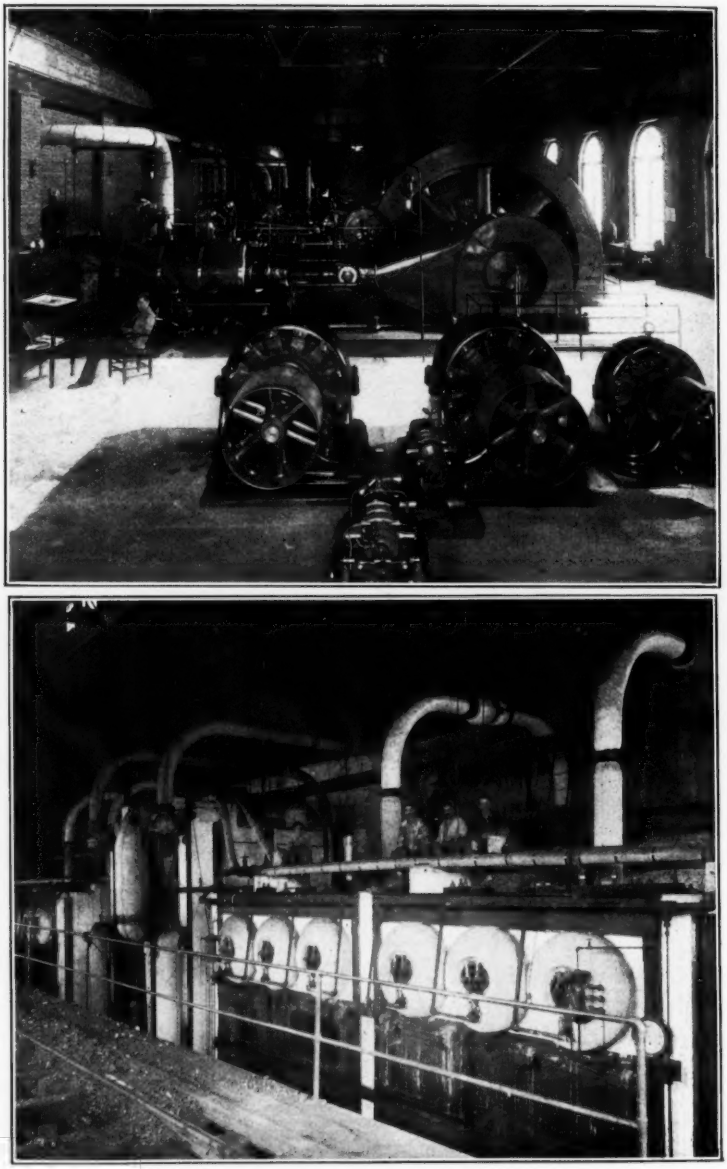
In this direction, the path marked out for the future appears to lie in a better relation between the superheating apparatus and the gases of the furnace—not a relation which shall provide a mere fixed and secondary position with regard to the heating element, with a



FOSTER SUPERHEATER IN WATER-TUBULAR BOILER OF HEINE OR FRANKLIN TYPE. One of ten units now being installed for Northern Colorado Power Co. under the engineering of Westinghouse, Church, Kerr & Co. The superheater receives heat through a side flue in the boiler setting, the gases making two passes and the heat being controlled by an adjustable damper. Pressure, 200 lb.; superheat, 100 degrees. Power Specialty Co., N. Y.

resultant degree of uncertainty and often undesirable fluctuation in effect; but an arrangement which shall provide some more definite and controllable share in the disposition of heat. The value of the superheater appears to justify a position in a boiler setting in which it shall not be expected to operate merely by the capricious eddies and flows of half-cooled and intermittent gases; it should be so placed that it shall receive its due proportion of heat flow, and that it shall not be exposed to superfluous heat when the demand for its work has slackened, nor be restricted so as to be unable to respond to an increased demand.

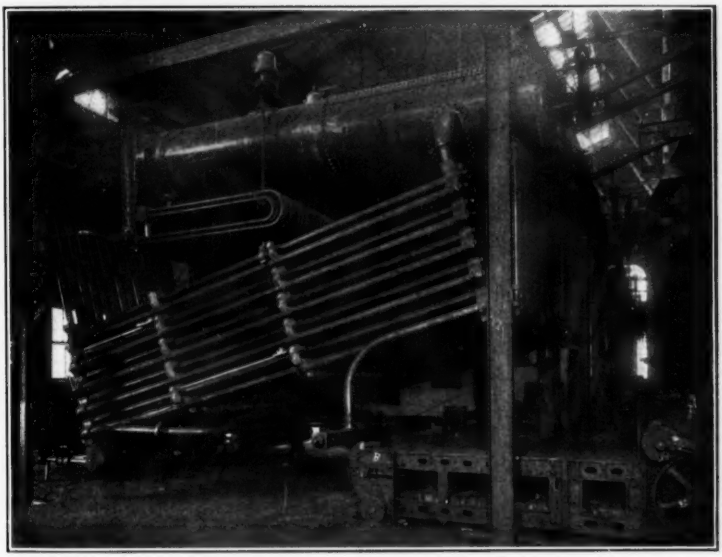
The extent to which any boiler and furnace combination can afford to divert heat to a superheater is ascertainable. Manifestly, the gas temperature must be considerably in excess of the final steam temperature, and if the waste gases go off at an economical temperature, as for example one lower than 500 degrees F., there is little



RICE & SARGENT ENGINES FOR HIGH SUPERHEAT AND SEPARATELY FIRED SCHMIDT SUPERHEATER, EDISON ELECTRIC ILLUMINATING COMPANY'S STATION, LANCASTER, PA.

Three engine units, each of 1,500 horse power; size 26 and 50 by 48; poppet valves on high-pressure cylinders. Providence Engineering Works, Providence, R. I.

superheating to be accomplished with steam at 150-pounds gauge pressure, the normal temperature of which is 365.7 degrees F.; an addition of 100 degrees superheat to this would bring it practically to the mean temperature of the escaping gas. If such a temperature be required, the superheater must be placed where the temperature of the gases is considerably higher, and where, after the abstraction of the necessary heat for the superheat, they will still be at a temperature high enough to enable them to effect the necessary chimney or draft work.

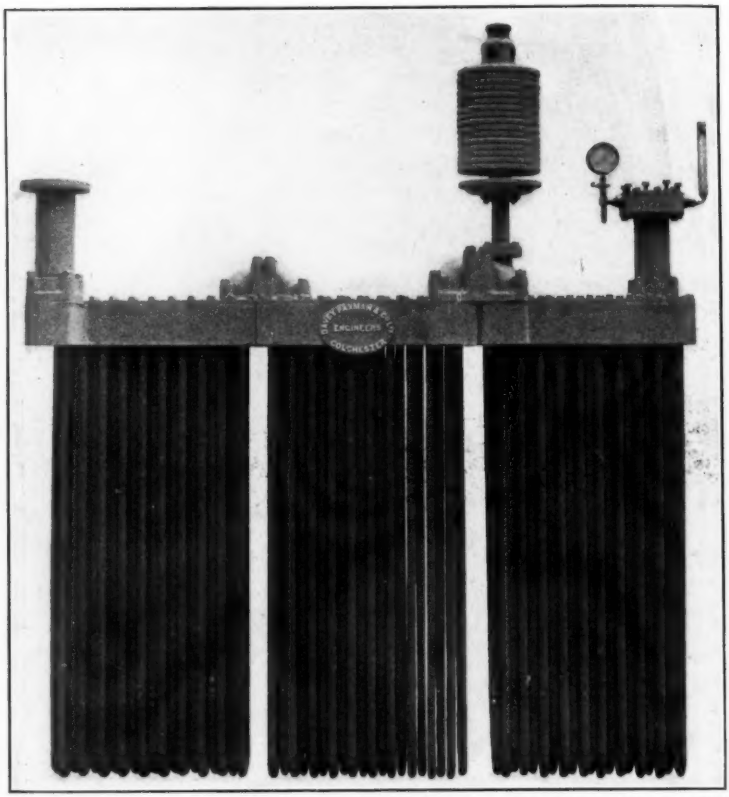


BABCOCK & WILCOX BOILERS AND SUPERHEATERS, KIRKLAND AVE. PUMPING STATION, CLEVELAND WATER WORKS, CLEVELAND, OHIO.

Each boiler is 14 sections wide, 10 tubes high, 18 ft. tubes, with two 36-in. drums. Working pressure 200 lb.; 800 horse power. Superheat 150 degrees. Chain-grate stokers. Babcock & Wilcox Co., N. Y.

This has led to the now rather usual practice of placing the superheater in the upper part of the second "pass" of gases in the horizontal water-tube type of boiler so widely in use. In such a position, good work can be obtained at moderate degrees of superheating, generally below 150 degrees F., and more commonly below 100 degrees. The relation between heating surface and superheater surface under such conditions varies very greatly with the location and the gas path.

In a test of water-tube boilers, bearing a relation of superheating

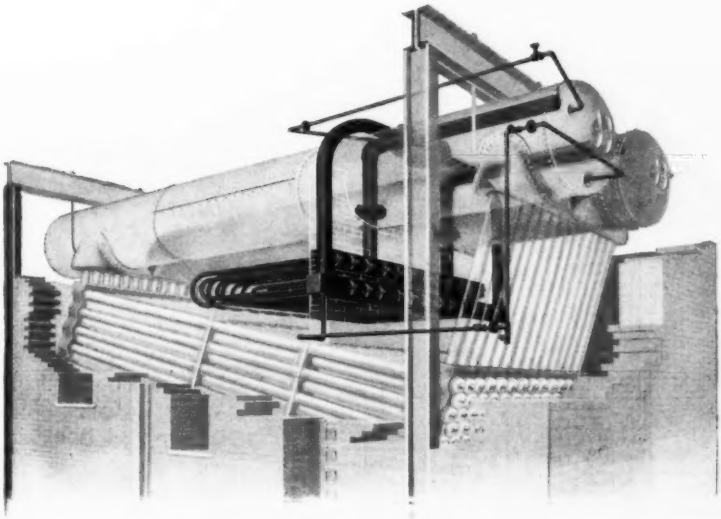


SUPERHEATERS BY DAVEY, PAXMAN & CO., COLCHESTER. THE BOXES ARE OF MILD STEEL.

surface to heating surface and grate area of 34 per cent and 1 to 16 respectively, and burning per square foot of grate 12.97 pounds of dry coal of 13,488 British thermal units heating value per pound, steam at 151-pounds pressure was super-heated 21 degrees F.

In a test of a combination of a superheater with an Edgemoor water-tube boiler, coal of 14,060 heat units per pound was burned at the rate of 25.5 pounds per square ft. of grate area per hour; the gases furnished passed into a Schmidt super-heater, the details being:—

Grate area, 66.8 sq. ft., or 5¼ per cent. of the superheating surface.
Water-heating surface, 3,332 sq. ft.
Superheating surface, 350 sq. ft., or 10½ per cent. of heating surface.
Steam pressure, 147.4 lb.
Flue gases, 582° F.



"PHANTOM" VIEW OF BABCOCK & WILCOX SUPERHEATER, SHOWING ITS RELATIONS TO BOILER AND SETTING.

The steam entered the superheater at 365.6 degrees F., and left it at 809.1 degrees, an addition of 443 degrees, the combined evaporation of both boiler and heater being 7.09 pounds, equivalent to 10.07 pounds from and at 212 degrees, affording a combined efficiency of 69.2 per cent.

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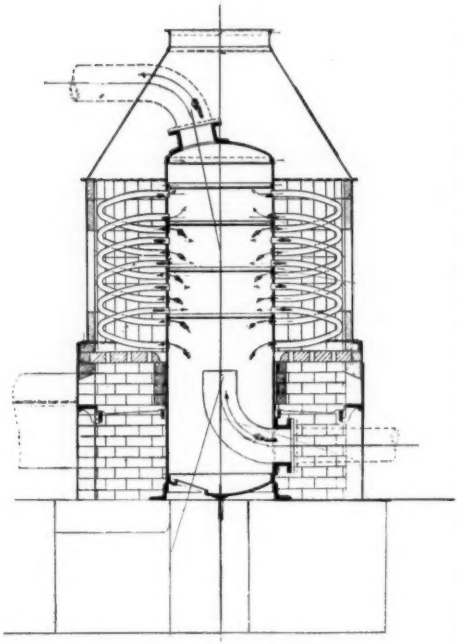
The literature of this important and absorbing subject is of a peculiarly meagre and scattered character, not readily accessible to those to whom it is most desirable that it should appeal. Much of it consists of records of tests in which added heat has been applied to pre-existent combinations, affording, as has been said, gratifying but misdirecting results. But even such partial indications are of value, since so many ineffective plants are in existence, the owners and engineers of which may derive a practical interest in the subject by ascertaining what others have accomplished in some direction nearly parallel to their own conditions.

I feel, therefore, that the widespread circulation, by means of this Magazine, of even a partial bibliography of the subject will be justified, and a study of any, or all, of these can be recommended to all



INDEPENDENTLY FIRED SUPERHEATER.

Supplied to Leeds forge for superheating steam from several Lancashire boilers. B. R. Rowland & Co., Reddish, Manchester.

classes of power engineers. The bibliography below is compiled in collaboration with the Editors of THE ENGINEERING MAGAZINE, and is drawn chiefly from the volumes of the Engineering Index. A very broad general division is made, according to the tenor or character of the articles indexed, and below that the arrangement is chronological. The period covered is about fifteen years.

It is gratifying to be able to state that the presentation of the subject before the esteemed American Society of Mechanical Engineers by Thurston, Carpenter, Foster and Hutchinson has been of high and leading character, inviting to it the attention of the members at regular intervals in the past ten years—an attention which has been further maintained by the active and intelligent interest of the engineering press.

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A THEORY OF STORES OPERATION FOR MACHINE SHOPS.

By H. L. Whittemore

While correctly styled a "theory," Mr. Whittemore's article is truly an expression of practice reduced to its essential principles. The ideas as here given were worked out in the management of the stock room of an electrical manufacturing company of international range and reputation, and proved thoroughly useful.

Stores keeping is admittedly one of the departments of works management which has not yet been generally brought to a fully satisfactory solution. We are glad to offer, in Mr. Whittemore's discussion, a really significant contribution to the subject. And it will serve to offset, for many of our readers, the disappointment arising from the regrettable but necessary interruption, for this one issue, of Mr. Carpenter's series on "Profit-Making Management."—THE EDITORS.

THE importance of a separate department for the care and storage of material, in a modern manufacturing plant, has caused great attention to be paid to the subject. Much of the information which has become available, however, deals more with the arrangements for storing the material to allow proper access, and to the routine, including the printed forms used, than it does with the fundamental considerations governing the kind and quantities of material to be stocked. Of course, the final solution of these problems depends upon the particular case under consideration, but there should be some guide for such work which would prevent serious errors.

In most cases, the quantities are fixed by rough estimation and corrected, if at all, after experience has proven them unsuitable. Different persons frequently disagree as to the necessary quantity, and even estimates made by the same person, under identical conditions, have varied widely, tending to prove that the estimate was based very largely upon "guesswork."

Such confusion in determining the diameter of a shaft in designing a machine would hardly be possible. While neither case is capable of an exact solution, it has been found that an investigation into the theoretical considerations has been an assistance in design; possibly it would also prove profitable in the case of "stores." Even if mathematics can not be used to advantage, there are certain relations between the quantities fixed for any one article, which, if kept in mind, should put the work on a more rational basis.

If manufacturing be defined as the raising of material in value, from the condition found in nature, by the expenditure of human

energy or work, a stores, as a factor in that operation, is the systematic care of such material when not actually undergoing the manufacturing process. By its very nature, it plays a passive rather than an active part, being in fact a *reservoir* and subject to the law governing them, of being able to discharge only what it has first received. The capacity is not as definitely limited as in some examples but is increased beyond a certain point only by the sacrifice of efficiency of operation. The sole function of a stores is to deliver the material, at some future time, with the lowest possible expense for storage.

The whole problem is one similar to that of transportation—the difference being that while transportation effects a transfer of material from one point to another, through an intervening *space,* time being only an economical consideration, a stores transfers material from one point to another, later point in *time,* any movement through space being for economical reasons only. The necessary condition, in either case, is that the material should remain unchanged during the transfer. The seasoning of lumber, ageing of wine, etc., by long storage, should properly be considered manufacturing processes in which time enters largely, but to be reduced if possible, as by the use of a dry kiln in the case of lumber. As time enters into all manufacturing operations, of necessity, these cases differ only in that the time element is greater than in some others.

In order to have all material in a stores accessible, it is not sufficient merely to provide for rapid handling of any particular article without disturbing other material, but exact information must be quickly available, at any time, as to the *quantity* in stores. While this may be obtained in some cases satisfactorily by actual measurement, when such information is wanted, it is generally necessary to provide a ledger of some kind, varying from a memorandum chalked on the wall near the material to an elaborate "card-system" which may be operated from a considerable distance. When reliable, this prevents the loss and annoyance due to overlooking material which might have been used or of finding the supply exhausted when it is wanted immediately. Considering the many forms which this record has taken in actual practice, there should be little trouble in selecting one which would suit almost any conditions.

Besides these general features, which apply more or less to all stores, those for machine shops are usually burdened with the duty of ordering a new supply of material as the stock of certain articles decreases, thus maintaining automatically a constant stock within certain limits fixed by the management. These limits are one of the most

important features of such an arrangement, because if they are not great enough there occurs a constant loss due to shortage of material, or if they are too great, again a loss due to the idle capital which such a stock represents—often a large sum.

A graphical history of a stores, for the purposes of discussion, may be made as shown in Figure 1. This is really a graphical ledger account, for some one article, showing the balance or number in stock on any day during the time covered. The vertical lines which should represent Sundays have been omitted; a great help in using a calendar diagram of this kind. Material actually in stores, or "stock," is plotted above the zero line, while that for which orders have been received but no stock is available are plotted below. In general, these diagrams may be taken to represent finished machines or parts.

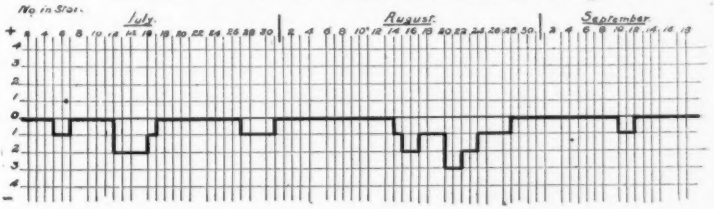


FIG. 1. TYPICAL CHART OF STORES BUILDING TO ORDER ONLY.

From the time one of our "hairy ancestors" rudely fashioned a weapon for another "apeman," down to the present, the manufacturer has always if possible made certain that there would be a market for his wares, when complete. This is assured, usually, by obtaining the order or customer's promise to purchase. Under such conditions, no work is done and often no raw material is obtained until a customer is found. This is the case in Figure 1, in which the stores consists only of a record of machines to be "*built*" and perhaps material to be obtained.

When the demand for an article, instead of being spasmodic and infrequent as in Figure 1, increases and becomes fairly constant, the same course leads to "*manufacturing*" it as shown in Figure 2, in which, for convenience, the orders are all supposed to be received each day before the stock to fill them is turned into stores, although it may have been in work for days before. The production is assumed approximately constant at 285 pieces per day, and while the orders vary the average is about the same, so that the number in stores averages zero. When the production falls, for any reason, as on July 31, to 175 pieces, any small stock which may have accumulated is quickly wiped out.

This manufacturing in large quantities leads to the development of much special machinery suitable only for the production of a very limited range of work but wonderfully efficient within that range. This in turn reacts to increase the demand. Such cases have given the United States, especially the New England portion, credit for the devising of practically revolutionary methods of increasing output. Whether this success has been due to circumstances or to a peculiar aptness of the people for mechanical invention, in the same way that the Romans were especially gifted as law-givers, may be a question. There can be little doubt, however, that the conditions and the rich natural resources placed an enormous premium upon the ability to produce useful material results.

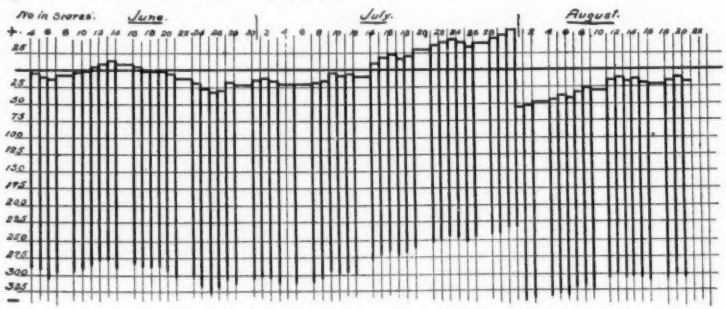


FIG. 2. MANUFACTURING FOR STORES, WITH FAIRLY CONSTANT PRODUCTION.

The low cost attained by the use of special means of production for articles in great demand, which may be called "*continuous manufacture*" when all the processes are in simultaneous operation, as in the case of a flour mill, naturally leads to the attempt to apply the same methods to articles for which the demand does not warrant the constant operation of an especial equipment. If however, as is often the case, the range of application can be made to include several articles, much alike, the equipment can be operated upon one of them for a certain length of time, then altered where necessary and operated upon the next, so obtaining the low productive cost for each in turn. While the reduction may not be as great as would be possible were the demand sufficient for continuous production, it is often a startling improvement over the previous method. The turret lathe is a typical example of such equipment. As a usual thing, the expense of preparing to make any given article, or "setting-up," is considerably greater than before, making it necessary that such expense be distributed over a number of pieces before any saving in the cost of each piece is effected over the older method.

Supposing the customer's orders to be for small quantities which individually did not warrant "setting-up," they might be allowed to accumulate as in Figure 3, in which case 40 pieces are completed at a time whenever customers have been found for them.

From the producer's standpoint this is the ideal method of obtaining the lowest possible cost, but the customer is seldom inclined to wait after his order has been placed until such time as the manufacturer can execute the work at the least expense, even though he may share the benefit in a correspondingly low purchase price.

So far it should be noted that no "stores," as a concrete place to store material, has been necessary. Only in the last case was the need for something of the kind particularly noticeable, and it is probable that the stores has been principally developed in the comparatively recent attempt to manufacture in large quantities, much more rapidly than consumption demanded—then to use the tools, perhaps for many months, on other work.

The delayed delivery necessary in Figure 3 may be overcome by manufacturing in advance of the orders and stocking as in Figure 4, or if the delivery need only to be shortened, the zero line may be at some intermediate point as A-B. The length of time which the "curve" is below the line A-B should in no case, however, exceed the allowable delay in shipping the goods to the customer.

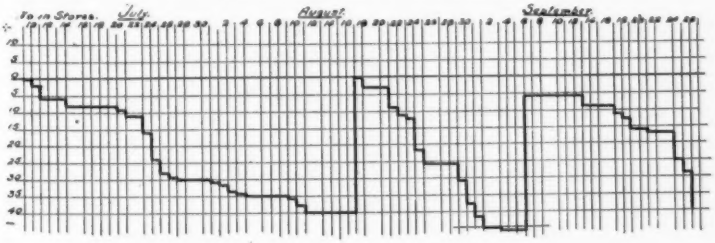


FIG. 3. CHART SHOWING MANUFACTURING FOR ACCUMULATED ORDERS.

Every article must satisfy the customer in the following three particulars. 1, design, which includes material, workmanship, etc. 2, price; and 3, delivery, or the time interval between the receipt of the customer's order by the manufacturer and the shipment of the goods. While the last has, for most articles, assumed particular importance only in recent times, it now often takes an equal rank with price. All these requirements are given to the shop or production department with the order as part of their instructions. While the design and delivery are not to be departed from in any particular, the "factory

cost" may and should be made as low as possible. It is, in fact, the variable which measures the efficiency of the production department. These instructions to the shop (drawings, etc.) which are prepared first by the sales department, then amplified by the engineering, drafting, and specification departments successively, are theoretically the customer's description of the article ordered; the salesman acting as his representative and the engineering department as his engineer.

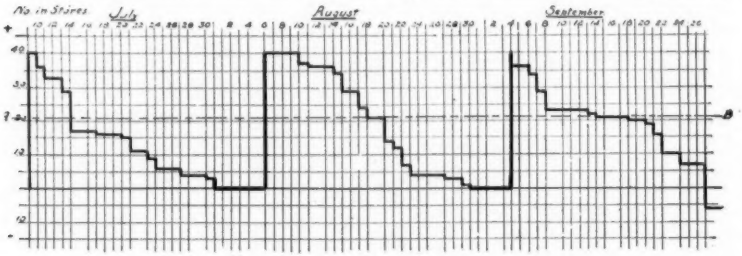


FIG. 4. CHART SHOWING STORES MANUFACTURED IN ADVANCE OF ORDERS.

A stores, from the production department's standpoint, may be defined as a machine or tool for shortening the delivery upon an article. It makes possible instant delivery in any quantity. In addition to those cases in which the instructions require a delivery impossible without a stores, the production department should, in all cases, stock any article, in any quantity, when the cost of production can thereby be reduced more than enough to pay for the cost of storage. This is the case in Figure 4. Suppose a delivery of three or four days, as in Figure 1, is satisfactory—long enough to make the article if the orders are taken individually. The article is stocked to meet this delivery and also allow of making in lots of 40, which greatly reduces the cost of each piece.

Referring, again, to the transportation parallel, it is seen that this last phase of the stores problem is very similar to one in which the production department has instructions to deliver a given article at a certain place, say A. If it is possible to manufacture it at A, no transportation will be necessary; if otherwise, it must be made elsewhere, say at B, and transported to A, the cost of transportation to be included in the final cost of the product. The production department should, however, be free to manufacture at any other place than B, say C, provided the cost at C plus the cost of transportation to A is less than the cost delivered at A from B, or made at A.

The conditions governing stocking imposed by the sales department, depending as they do on what the customer will purchase, are

incapable of analysis; but those affecting the production department in reducing cost may be quite definitely worked out.

Figure 7 may be taken to represent a general case, for an article which it is necessary to have in stock with little chance of failure. In order to make the instructions to the stores definite, so that responsibility can be fixed in case of need, there are two quantities which once fixed will meet most requirements for the purpose of ordering material to renew stock. The first determines when it is to be ordered, preferably by reference to the amount of stock in stores, and the second determines the amount to be ordered. Perhaps the simplest way to connect the first with the stock is to fix a quantity which may be called the "base." This depends upon the delivery required by the sales department and may be fixed directly by them. When the stock falls to, or below, this base (G-Q, Figure 7) the order for stock renewal is issued for the quantity fixed for that purpose, G-A. This order quantity should be the most economical quantity to manufacture, as determined by the production department. If considered important, the quantity under way in the shop may also be taken into account, as is sometimes done in practice, but that is rather beyond the province of the stores proper. The supposition here is that when one order is isued, it is completed, and the stock replenished before another is necessary, although that is not necessarily true in practice.

The sum of the base and the order quantity is a true maximum, seldom reached in actual practice because stock is drawn from stores between the time the order is issued and the time it is completed. It serves, however, as a basis for figuring the amount of capital represented under extreme conditions. Usually the new stock is all received in stores at the same time, as shown by G-A, Figure 7, although that need not be the case. The time interval between two such events is not of great importance, but may be approximated by drawing a line A-B, from A, a point on the maximum line, and falling toward B at the rate equal to the average demand. The heavy broken line, showing the actual demand for that period in one instance, follows it more or less closely though it need not cross the base at the same point. A-B is simply the forecast of probabilities and the limits A′-B′, and A″-B″, may be drawn, if desired, to show, from past experience, how closely the actual demand may be expected to adhere to the forecast.

A-B need not be a straight line, for if the demand for a long period of time, say a year, is plotted, as in Figure 5, a relation between the season of the year or other factor and the demand may be

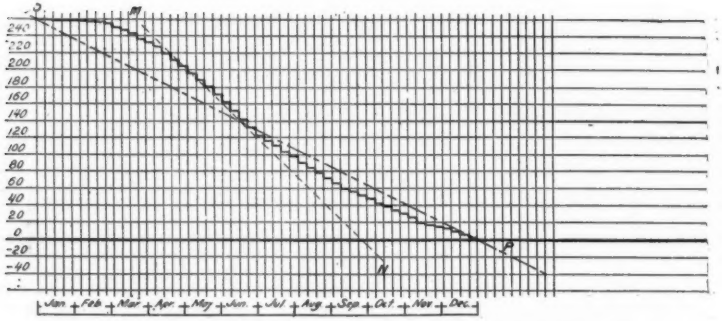


FIG. 5. CHART SHOWING SEASONAL DEMAND AND PRODUCTION.

observed, and in general such relations would be represented by curved lines. Figure 5 might show this for automobiles or ice-cream freezers. The maximum demand, M-N, is about twice the average, O-P, and the minimum is almost zero in January. Such a diagram would also show the extent of the fluctuations, as in Figure 6, in which A and B both have the same average demand but the fluctuations from that average are many times greater in the case of B. Really the only useful portion of these limits is the portion of A″-B″ below the base, which indicates, in all probability, the minimum time, Y-B″, which will occur after an order is issued for stock renewal, until the stock will become exhausted if not renewed. The average time required for production of the order may be laid off, as at Y-O, and a longer time, within which the completion is actually to take place, as Y-P. This date may be given to the production department, with the order, as part of their instructions and the matter brought to the attention of the management at that time if the stock has not been received. There would still remain the time P-Q, before the stock would fall to zero, as shown by the line A″-B″. The ratio of P-T to P-R may be called the, "factor of safety."

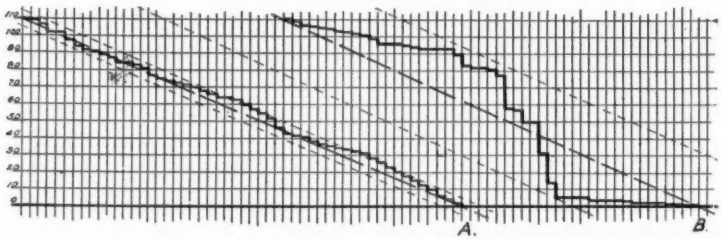


FIG. 6. CHART SHOWING FLUCTUATIONS OF DEMAND AS RELATED TO PRODUCTION.

The average number in stock may be calculated as one half the sum of A-S plus R-T, or U-V, and the average length of time each piece remains in stores, this quantity divided by the rate of demand shown by the line A-B, or V′-Y, if U′-V′ be made equal to U-V. In order to obtain the actual final cost of an article, the factory cost consisting of the labor and material should be increased by an amount sufficient to cover the expense of storing for the average time. If for simplicity this is figured as a percentage of the factory cost, probably accurate enough for material of the same general class, a diagram, Figure 8, might be used in comparing costs under different conditions. This percentage, compounded annually, should of course, be greater than that usually considered sufficient for interest upon capital by the cost of operating the stores, and enough should be added to cover the risk of the stock becoming damaged during storage or becoming ob-

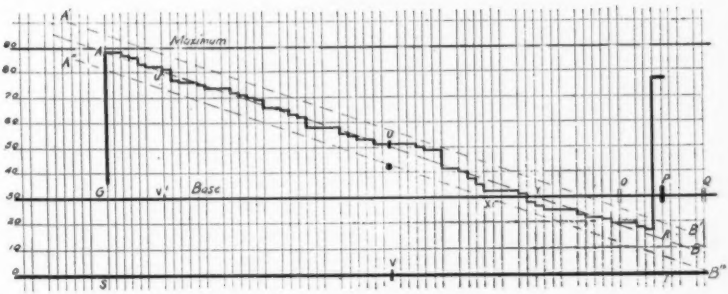


FIG. 7. CHART SHOWING MANUFACTURE WITH BASE, MAXIMUM AND MINIMUM LIMITS, AND ORDER QUANTITY.

solete in design. Taking for a basis the cost of the article when made as required (see Figure 1-2-3.) the extent to which the factory cost must be reduced when making arrangements for the article to be stocked may be read from the diagram in percent of the unstocked cost. Any reduction below this represents a lowering of the final cost of the article. For example, if the cost of stocking is 20 per cent per year of the factory cost, then the cost when made in such quantities as to give an average time of two years for each piece in stores must be reduced to 69 per cent at most of the unstocked cost. If the unstocked cost is unknown, a comparison may still be made between a tried and a proposed quantity for stock by using the diagram to find the difference which should exist between the factory costs so that the final costs may be the same. The production department may then determine, either by estimating or by actual trial of such an order quantity, whether or not the reduction can be effected. It might, also, be used

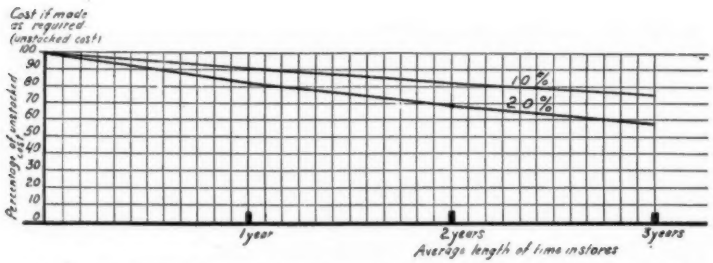


FIG. 8. DIAGRAM OF COMPARATIVE COST OF MANUFACTURING IN DIFFERENT QUANTITIES.

to show the reduction in purchase price of raw material to be obtained as larger quantities are purchased and necessarily stored for longer periods.

The base and order quantities in Figure 7, *may* be any whole numbers when machine parts are concerned, but usually only "round numbers" are used, as exact determinations of proper quantities are impracticable. In order to crystallize this tendency, it might be advisable to prepare a table of these numbers and allow no others to be used. Clerical work in cost accounting would be reduced if decimal numbers only are used.

Any table of this kind must necessarily be adapted to the service for which it is intended.

In order further to simplify the ledger work in the stores and elsewhere, each part is usually identified by some symbol, such as a number. There are several systems in use for this purpose and the same symbols usually serve both for the stores and cost systems, as well as the part list from which a customer orders spares.

In general, material is not stocked in continuous manufacture from the time the raw material starts through the manufacturing processes, until complete. All the operations being simultaneous, the average amount of material passing through any one can not be greater than that passing through any previous one, and if greater than that passing through any subsequent one the difference must accumulate indefinitely between the two operations. While, therefore, the maximum capacity of the different machines may be very different, the average must be the same and not greater than the least.

Intermittent manufacturing, however, presents a rather complicated problem, as an article may be stocked after each and every operation, although that is seldom desirable. Each stocking involves an expense for clerical work and transportation to and from the stores,

independent of the length of time spent there. Therefore, the lowest final cost will be attained by stocking as few times as possible, other things being equal.

Most machine parts are completed separately, then assembled to form the machine. This may be represented by Figure 9. Any part moves, upon this diagram, vertically downward from the Raw Material Stores, A-B, upon the line bearing the identifying number for that part through the necessary operations, to the Completed Part Stores, C-D. The parts are then assembled as indicated, on the horizontal lines, one for each machine, identified by letter, finally reaching the Complete Machine Stores, D-E. All of these stores may be one and the same and located in any position in the works that is convenient. The fact that any part or groups of parts is stocked, is indicated at the proper point on the lines by a circle, as in the case of Piece No. 5, between the foundry and machine shop.

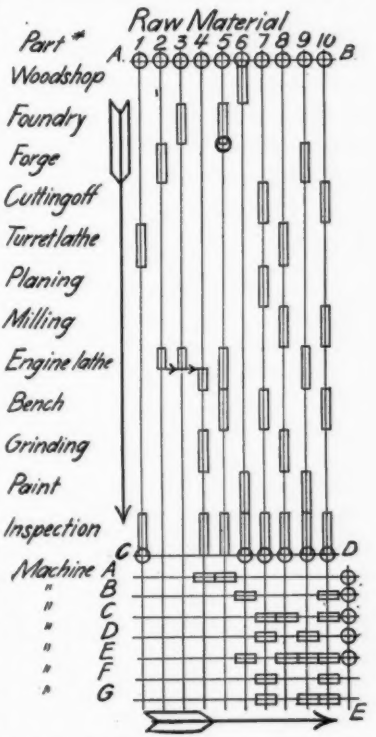


FIG. 9. DIAGRAM OF PROGRESS OF WORK THROUGH STORES.

While this is merely arranged as it is for convenience in using the diagram, it may be pointed out that the actual arrangement of some modern shops is similar. The erecting shop is situated, as shown by C-D-E, across the end of the machine sections, A-B-D-C. The arrows, in both cases, indicate the direction of crane travel, and in a general way the course taken by the material.

Roughly, it would seem that material should be completed as far as possible before stocking. A stores containing 1,000 pieces, ready for shipment, is less likely to experience a shortage of that article than is one containing 500 finished and 500 upon which one-half the labor has been expended. The cost of raw material is often a large proportion of the cost of the completed article, and after this material is

once assigned to that article, and work commenced, it can no longer be diverted for the construction of any other article. In the second case just mentioned, the 500 pieces, half-finished, may represent three-fourths of the cost of the finished pieces, but they are unavailable for filling orders. They can, of course, be completed more rapidly than raw material, an important factor when that involves much time. As the expense of stocking may be divided into a fixed charge, plus a charge proportional to the time the stock remains in stores, it can easily be seen that it is cheaper to stock the finished article for six months than the finished and the half-finished article each for three months.

If necessary in order to keep enough work ahead for some of the departments, work which it was considered undesirable to keep on the floor near the machines might be turned into stores for temporary storage. In such a case the stores need not count or otherwise verify the number delivered, but simply receive the package for safe-keeping as is done with valuables placed in a safety deposit box. Such material would not appear on the stores ledger, but would be withdrawn by the department entering it whenever they were ready to work upon it.

Piece No. 1, Figure 9, represents say, a wood screw and is not stocked before it is completed ready for shipment. It is not used in assembling any of the machines, A to G.

In practice, it is often very desirable to stock ample quantities at several stages of completion—for example, rough castings, in order that there may be no delay or uncertainty about starting work in the machine department at the time planned. In this case, the cost of storage and the loss due to scrapping castings which become obsolete in design, in spite of the greatest care, are far outweighed by the advantage of being able to depend with reasonable certainty upon a scheduled delivery. The most erratic link in the chain is often eliminated with the foundry.

An operation in which several parts are united to form a working unit or assembling, is illustrated by pieces No. 2-3-4-5. The first two are, we will say, the rod and piston for a steam engine which are shrunk or riveted together during the engine lathe operation, then finished together, while the last is the piston ring. The numbers, 2 and 3, are not necessarily to be used as symbols for the rod and head, as both are united in No. 4; but as No. 4 and 5 preserve their individuality when assembled and can easily be separated, they should each be represented by a symbol. Provided that No. 4 and 5 are always required together, there is no advantage in stocking either sepa-

rately, say at C-D, but they should be assembled in the way in which they are to be used and stocked at D-E. The raw material is then taken from the stores, in the proper ratio, say 1 rod, 1 head, and 2 rings, and carried to completion. Any departure from this ratio will cause an accumulation in the shop or stores of worked material which is useless until the material required to restore the ratio is drawn from stores and finished.

The most important practical bearing of this matter is when changes occur in design, which is remarkably often in many cases, and it is desirable to use all the pieces of the superseded design that may have been started before effecting the change. If the parts No. 2-3-4-5, were stocked at several stages of completion and without regard to the ratio in which they were to be used, it is very probable that many more of one piece would be found than of some others. There might be only 3 pistons and rods, but 150 rings which must either be scrapped or have pistons made for them—possibly a year's supply, so that the change could not be effected immediately.

Whenever an article is stocked several times before completion, care should be taken that the minimum stock is never less than the order quantity for any stocking which follows it, unless, of course, it is considered that the stock will have been renewed before another order quantity is drawn from that stock.

As distinguished from the assembling of several parts into one, it often happens that the same piece is used for assembling different machines, as No. 6-7-8-9-10. Any given piece follows exactly the course of all those known by the same symbol, until ready for assembling. Its final disposition may be any one of several machines, as No. 6 in machines B or E. If these are sold in different and fluctuating quantities it might happen, in emergency, that to obtain piece No. 6, for completing machine E, machine B, would have to be taken apart. A stock of pieces No. 6, at C-D, would prevent this and allow of their being held at this "parting of the ways," ready for use wherever required. As assembling, in general, requires but little time, it would seem preferable to stock as large an amount of finished parts as necessary where they were used in more than one way and a comparatively small stock, possibly none, of the assembled machines. Machines F and G illustrate cases in which the time allowed for delivery is long enough to assemble the parts stocked at C-D.

In the same way, if goods were made in New York and sold in both St. Louis and Milwaukee, one stock at Chicago, near enough to fill orders quickly, would be better than a stock at both the places, in

which latter case it might easily happen that goods would have to be shipped frome one to the other, through Chicago. This is especially true if the supply is scarcely equal to the demand and the latter is fluctuating.

The peculiar case sometimes occurs of pieces which are ordered by customers for spares to replace those lost or broken and which are not stocked separately. If this occurs often enough, a small number may be stocked if care is taken that they are not drawn when assembling stock machines. When a lot of machines is started enough should be made to complete that lot.

Groups of assembled parts can often be stocked to advantage, a thing which seems to be overlooked in some cases, the groups being so arranged that the more complex are obtained from the simpler ones by adding stocked parts, even when this requires additional machine work or the slight alteration of work already complete. For example, motor-starting resistance require face plates with or without a number of small pieces of apparatus such as maximum or overload release, etc. These face plates can be stocked and the unusual features added, or even some of those affixed can be removed; this greatly reduces the necessary stock of completed face plates. As the fastening screws are very likely to vary, in length at least, these are not stocked with the face plates but drawn as required. Small articles of this kind are very seldom returned to stores when not required, and so are lost or misused.

In the case of the face plates, the punchings, etc., were stocked separately in far greater quantities than the number of face plates required, because the production department could in that way reduce the cost; but the castings which were not made on moulding machines were ordered in large enough quantities only to meet requirements.

In general, then, as the greatest trouble in modern manufacturing appears to be shortage of material and so inability to make satisfactory delivery, it appears that attention should be turned to the stores as the proper mechanism for overcoming the trouble. While an article may necessarily be stocked to meet the delivery required by the sales department, it may be stocked in any greater quantity if cost can be in that way reduced.

An article should be stocked only when there appears an advantage in so doing; otherwise it should be carried toward completion and stocked as a finished piece, or still better in an assembled group of parts or in a machine. When, however, it may be used in more than one way, it should be stocked before rather than after its disposition is determined.

COST REDUCTION THROUGH COST COMPARISON.

By C. E. Knoeppel.

III. THE ORGANIZATION AND FUNCTIONS OF A COST-REDUCING DEPARTMENT.

Mr. Knoeppel's series began in our March number. His initial article discussed the record of burden costs, and his second installment took up machine, part, group, and operation cost comparisons. The paper now presented concludes the series.—THE EDITORS.

THE discovery of new methods of processing; the inventions of more efficient machine tools; the designing of better jigs; the introduction of higher cutting tool steels and cutting compounds; the eager search for more efficient methods and the enormous amounts paid to those who can devise money-saving systems, these all point to one significant fact—the desire for maximum efficiency. Some years ago the only question thought of was: "What are we doing?" Today it is: "What are we doing, what have we done, and what can we do? Some years ago desires were backed by experience; today they are backed by experience plus facts and figures. Some years ago "effects" received the greatest consideration; today it is "effects" and what caused them.

Modern business is no longer the game of chance it used to be. There was a time when a man could conduct his business on the "hit or miss" principle with some degree of success, but this policy cannot be practiced today; and while a number of concerns, classed as successful, are doing business without the assistance of the best equipment and methods obtainable, it is not *because* of this fact but rather in *spite* of it. The time is coming, if it is not already here, when the executive, in order to make his business a success, must so systematize his every detail as to enable him to see the end from the beginning. He will have to know where and how he is going—what he is doing and the why of it all, which means that he will know where his losses cease and his profits begin. Anyone can say "something is wrong," but the importance of being able to say "here is the fault" cannot be over-estimated.

What has caused the subject of "cost finding" to receive the attention it has from able writers? Why have the leading magazines, the

various conventions of manufacturers, and the yearly meetings of technical and other societies, given up valuable space and time to its discussion, and what has made necessary the advent of the "production engineer," "systematizer," "auditor" and "accountant"? Presumably the primary reason is the desire on the part of the manufacturer or business man so to conduct his business that the maximum output and profits may be secured. This being the case, why has the desire to achieve this ambition brought about the particular results outlined above? The underlying causes are, first of all, the complexity of modern business practice; the fact that each case presents its own peculiar conditions; the inability on the part of the executive to give the time to the study of his conditions or to the application of better methods, and the fact that the manufacturer does not care to experiment—he wants to feel sure that whatever is introduced will be accurate and productive of the most good. It therefore follows that the manufacturer realizes the importance of a system carefully devised, properly introduced, and wisely operated, and the keystone in this system must, of necessity, be an efficient method of cost finding in order that a reduction of the costs may be brought about. Inasmuch as the value of any system of costs is in proportion to the results obtained by it, the next question that suggests itself is—what must such a system accomplish in order that it may be pronounced successful? This can best be answered by reducing any system of costs into its fundamental elements, as follows:

Cost Securing.—The gathering of the many details through the instrumentality of shop orders, material requisitions, time cards, etc.

Cost Compiling.—The entering of the details secured upon forms and reports provided for the purpose.

Cost Comparison.—The placing of the latest information and data under or beside other information and data of like nature.

Cost Analysis.—The thought and deduction applied to the cost comparisons.

This will show that in order to reduce a cost, it must be analyzed by comparison; this depends upon proper compilation, and all again depends upon accuracy in securing the cost data.

No doubt every person who reads this article will know of one instance, perhaps several, where a cost system had been devised and installed, allowed to run for a time, and finally thrown out on account of its failure to cut costs; the result being that the mere mention of the word "system" has about the same effect on that manufacturer as would the flaunting of a red flag in the eyes of a bull. In other

cases systems have been pronounced failures but yet allowed to run on as best they could. A consideration, therefore, of the reasons why so many systems have failed to accomplish results would be next in order. The truth of the matter is that when systems have been thrown out or pronounced unsuccessful on account of their inability to perform their proper functions, their expensiveness, or other objections, an investigation would show, in the majority of cases, that the manufacturer himself and not the system was to blame. This may be due to one or more of a number of reasons, the most important one perhaps being business procrastination—or the inability on the part of the manufacturer to give more than passing attention to the points that vitally effect his business success; or, to put it another way, he is so engrossed by the consideration of details that *must* be attended to that the details that *should* be attended to are left to a more convenient season. In his leisure moments—if he has any—he may pick up a magazine that contains some valuable suggestions; at his convention he listens to a paper and discussion that appeals to him; but in his endeavor to secure business, to meet his obligations, to collect amounts due him, etc., the application of short cuts, better methods and suggestions is lost sight of for the time being. As a result, while the costs may be found and recorded, no practical use is made of the compilations. The system may be an excellent one, perhaps installed by a systematizer and capable of giving maximum results; but the best cost keeper in the world will soon lose heart when he realizes that his work does no real good. It may be, owing to the inability of the management, that several people have something to say about the costing, and unless they can all agree on a uniform policy (something quite unusual) the matter of using the cost compilations is out of the question, as the statements are bound to be misleading.

Another course which leads to disappointment with cost-keeping efforts is taken by some manufacturers who think that by putting in a few loose-leaf books, some cards with cases, and a few clerks to look after the records, they should obtain the desired results. A system in itself can do nothing, even with a bright clerk in charge, unless the co-operation of all concerned can be secured—a point oftentimes lost sight of. If A tells B to do a piece of work and B is dependent upon C for his information, it is impossible for B to force co-operation from C unless A has told C that the instructions of B are to be carried out. Another reason for the failure of a system to give results is sometimes found in the fact that it is experimented with—

patched and altered every time a new man takes charge. It is impossible for a concern to get results from a system radically changed from time to time, owing to the inability to compare items of like nature. To recapitulate, the causes of failure can be classed under the following headings:—

The application of systems that do not cover the conditions as they should.

Inability on the part of the management to give the systems and their workings the attention that they should.

Lack of co-operation among the heads of departments.

Too many changes.

Inefficient organization.

The question therefore suggests itself—how can these defects be obviated and how can the work be so handled as to result in maximum efficiency? After careful consideration, I am of the opinion that the answer of this question should be—the introduction of what may be called a "Department of Cost Reduction," in charge of a competent man who has supervision over and gives his whole time and attention to the securing, compilation, comparison, and analysis of costs, along with such other information as affects the success or failure of the enterprise. Before proceeding to elaborate upon the possibilities of this department, it is advisable to devote a few words to the qualifications and the authority of the man in charge, and to suggestions as to where he can get his information, with a brief list of possible compilations.

The chief qualification necessary in the man who is to manage this Department of Cost Reduction is the ability to take whatever information and data come to him and so to arrange and compile them as to enable him to use the data to advantage. Information is valuable in proportion to the facility of its comparison with information of a like nature, so that an important faculty in this man would be his ability to dissect the information and data he received as a surgeon would dissect a body, and then to reduce it in about the same manner as a mathematician would reduce a row of figures to a common denominator. Once dissected and reduced, it is an easy matter (provided the man in charge has some ability as a statistician) to draft statements that will aid in reducing costs. The ability to compile and to analyze should be accompanied by fearlessness in submitting his results; and if he is a gentleman in his dealings with his fellow men, the success of a department along the lines suggested will be productive of the desired ends. The truth sometimes hurts,

but if made known in a gentlemanly manner the sting is often removed.

To secure maximum results the manager of this important department should be independent of everyone with the exception of the president or general manager, in order that his suggestions and the results of his analysis may be properly taken care of. He should have full supervision over the compiling of all the available data as well as over the methods for securing these data. He should have the authority to secure any data of a special nature from any department of the business. He should have the right to lay the results of his investigations before the proper persons, and to expect that these results will be properly considered; and lastly, it should be understood that while he is to have no authority over anyone excepting the clerks who secure, compile, and classify the information he desires, his requests should be complied with; for in the exercise of his duties he deals with effects and results, and he must depend upon the co-operation of all in his attempt to find the underlying causes—the means whereby costs can be reduced. If the management will give these directions, no one will attempt to antagonize the man in charge of this department except one who might be afraid to have the results of his work known.

The data and information to be compiled by this "Department of Cost Reduction" or under its supervision are procurable from three main sources—shops, accounting, and sales departments, as follows:

FROM SHOPS.

Time spent on productive orders.
Time spent on general orders.
Material drawn on productive orders.
Material drawn on general orders.
Weight of materials shipped monthly.
Shop rejections.
Materials returned on account of defects, errors, etc.

FROM SALES DEPARTMENT.

Salesmen's expense books.
Salesmen's reports showing sales and to whom; lost sales by machines and to whom, etc.

FROM ACCOUNTING DEPARTMENT.

Sales by classes.
Purchases by classes and kinds of material.
Cost of collection.
Cost of advertising.
Burden expense such as taxes, insurance, salaries, depreciation, interest and discount, etc.
Freight and express bills.
Monthly balance sheet.

The possibility of this department becoming immensely productive as a factor in the reduction of costs can be readily appreciated if any person interested will stop to consider what the following data may mean to his business, providing the department is properly managed and the information used as it should be. The extent of the records will of course depend upon the size of the business, for a small concern would not need as extensive a list as shown, while a combination of concerns would perhaps desire an even more extensive one:—

Cumulative, average and monthly sales, with comparisons.
Cumulative, average and monthly sales by classes of machinery, with comparison.
Monthly sales by salesmen.
Monthly salaries and expenses of salesmen.
Materials returned, according to territory.
Record by department of materials returned owing to defects or errors.
Lost sales by salesmen.
Lost sales by machines.
Lost sales according to successful competitor.
Loss from bad accounts.
Cost of collection and advertising.
Record of the various classes of purchases each month, showing the departmental, productive, and maintenance materials, material for the drawing room, offices, plant betterments, etc., with comparisons.
Record of the various kinds of materials such as pig irons, cold rolled steel, tool steels, babbitt, cutters, etc.
Cumulative, average, and monthly shipments in pounds.
Departmental productive and non-productive rates per hour.
Cumulative, average, and monthly burden statements, with comparisons.
Record of rejected work by department.
Monthly balance sheet, showing increase or decrease in assets and liabilities over the previous month and over the same month of the previous year.
The cost of operations, with comparisons.
The cost of parts, with comparisons.
The cost of groups, with comparisons.
The cost of machines, with comparisons.
The cost of contracts.
Record of sales by machines showing the gain or loss.

We will suppose that a department such as I have suggested has been introduced by a manufacturing enterprise, a competent man placed in charge, the organization arranged so that he has the authority to secure whatever data he may require. After a few months run, what may one expect from this department?

From the salesmen's reports, this department will have secured all the information it can regarding "lost sales"—who lost the sale, the territory, the date, the name of the successful competitor, the name of the article or machine, the amount of the lost sale, and the reason for its loss. All this information can be so arranged and

classified as to show which territory needs the most attention—the salesman who is losing the largest number of sales—what competitor is making the greatest inroads on the business—what machines are hardest to sell and why. We will suppose that the compilation of lost sales by machines and their reasons is receiving the attention of the manager of this department. He notices that the lost sales on the "X" machines amounted to $20,000 for the following reasons—

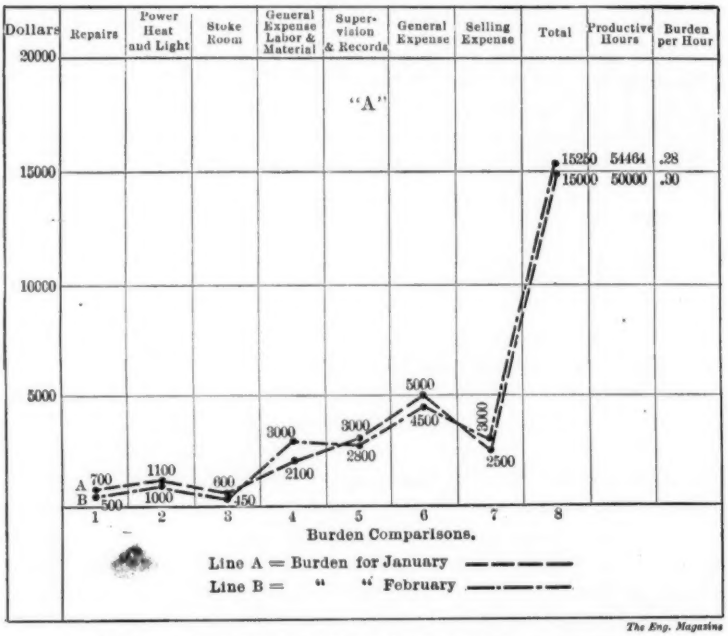
They are unsatisfactory in their work;

The price is too high.

This attracts his attention, and on turning to his file of sales by machines showing costs, profits, and losses—(Form F, page 78, THE ENGINEERING MAGAZINE, April issue)—he finds that there is an excellent margin of profit on the machines which have been sold, and concludes that if the price can be lowered and an effort made to overcome the fault in the machine, the company stands an excellent show of regaining its losses. It also occurs to him to look at the machines that sell the best, which might show him that the price is so low and the margin of profit so small as to admit of easy sale. He can also take up the investigation of sold machines on which losses have been incurred, and by investigating the question of design, costs, prices of competitors, etc., with the one higher up, these compilations of sales and lost sales at once become of great assistance in increasing business as well as profits.

Upon finishing his burden report for February and entering it upon a comparative sheet as shown in Form A, he notices that the burden per productive hour was less by $0.02 than in January, although in money it increased $250.00 which in itself is not a "startling" increase. As the business of the man in charge of this department is to analyze, he begins to note the various increases and decreases; he finds that in columns 1, 2, 3, 5, and 6 the money expended was less than during the previous month, but in column 4 the increase was $900.00 and in column 7 $500.00; while these increases may be legitimate, it remains for this fact to be proven by an investigation (as described in my article in the March issue of this Magazine) which might prove—as it often does that it does not pay to jump at conclusions.

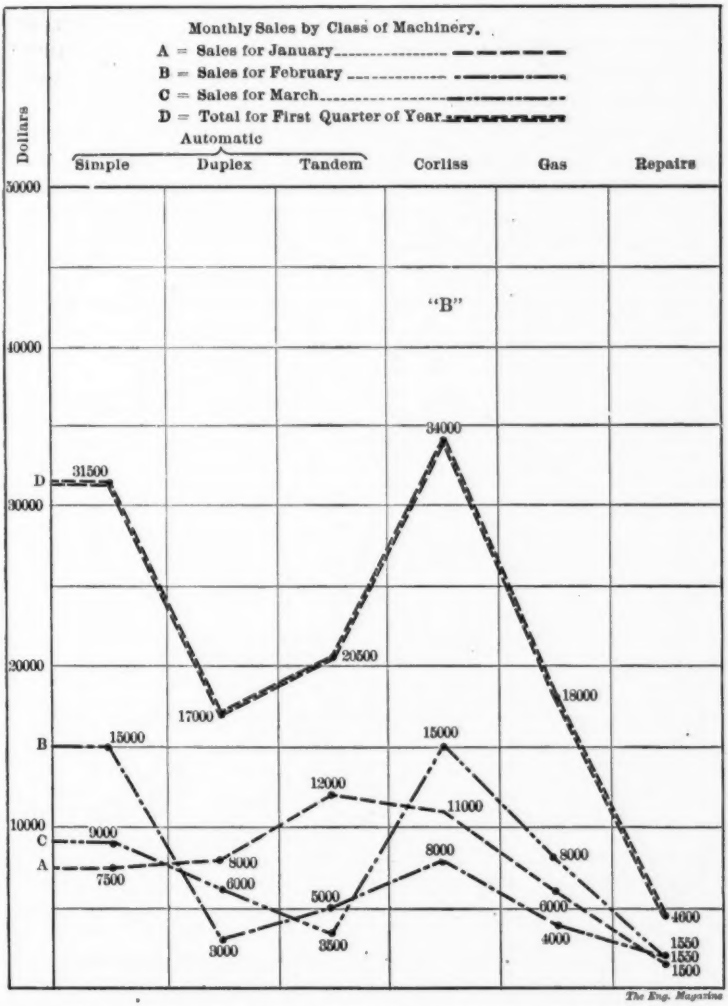
The manager of this department, we will say, has compiled records according to the kinds of materials such as babbitt, cold-rolled steel, coal, etc. On a certain morning a salesman representing a babbitt house steps into the office, and after demonstrating the superior qualities of the babbitt, the manufacturer decides to give



FORM A. COMPARATIVE DEPARTMENTAL BURDEN, BY MONTHS.

him an order. He asks the manager of this "Department of Cost Reduction" if he can give him the approximate amount used in a year; it is only the work of a moment to find from his records the average consumption by classes, which he hands to the manufacturer; from this list the latter finds that he uses about 15 tons of genuine babbitt yearly, so instead of giving this salesman an order for a few kegs, he buys a large quantity on which he saves quite a little. The classification of such items as novo steel, belting, reamers, drills, drawing-room papers, etc., in this way would often enable the manufacturer to purchase more reasonably. It takes time, to be sure, but consider the possible saving.

An analysis of the comparisons as shown on Forms B and C might be productive of desirable results. Take Form C for instance. The manager, on looking over the monthly sales, noticed that the sales dropped from $43,050 in March to $31,000 in April, although the trend from then until August was steadily upward. In September, however, a slump occurred, the decrease being $21,000. By looking at the record of Form B for the proper months he could



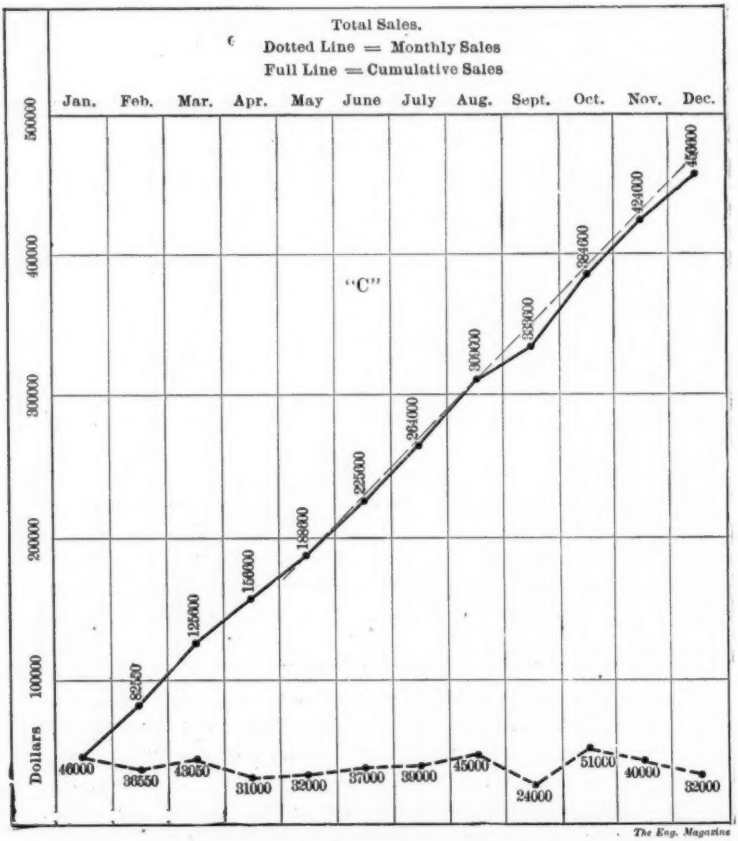
FORM B. COMPARATIVE SALES, BY CLASSES OF PRODUCT AND BY MONTHS.

find the class of machinery that was responsible for the slump, and from there he could take up the investigation of his burden for the month, the record of lost sales, and the sales by machines, all of which would perhaps enable him to locate the cause of the slump.

A record as shown in Form D might enable the management to determine whether the amount spent for repairs was in proportion

to the investment or not. If not, they could easily trace back and locate the machines or buildings that required the most repairing, and by putting them in the best possible shape, might considerably reduce the repair expense.

As the selling expense is a large item, this department naturally undertakes the compiling of data secured from the salesmen's expense books which will show the amounts expended by each salesman for mileage, sleeper, hotel expenses, etc.; while a salesman is not responsible for the first two items he is for all others, and by totaling the net expenses, and dividing by the number of days on the road, the salesman's average daily expense can be determined. Adding his net



FORM C. COMPARISON OF TOTAL SALES.

expenses to his salary and his commissions will give a sum which, divided by his sales during the month, will result in the per cent of cost. This information, in conjunction with the information regarding his lost sales, the returned materials from his territory, and the complaints, etc., will enable the sales manager to pass upon the efficiency of his salesmen as well as furnish the means whereby sales costs can be reduced.

"D" BURDEN COMPARISON

ACCOUNT REPAIRS.

PERIOD	TIME	AMOUNT	PER HOUR
JANY	4000 Hrs	$ 1500 00	.03
FEBY	4100	1300 00	03 1/4
MARCH	3700	1200 00	.03 1/2
APRIL	4700	1700 00	.04
MAY	4200	1400 00	.03 3/4
JUNE	3100	900 00	.02
JULY	3900	1100 00	03
AUG	4300	1600 00	04 1/4
SEPT	4400	1650 00	.04
OCT	4100	1500 00	.03 1/2
NOV	3900	1200 00	.03 1/2
DEC	3500	1100 00	.04
TOTAL	47900	16150 00	
AVERAGE	3992	1345 83	.035

FORM D. COMPARATIVE RECORD OF REPAIRS.

After the "comparative cost reports" (See Form E, page 81, THE ENGINEERING MAGAZINE for April, 1907)—are returned to the department of cost reduction they can be filed according to department and workman. This file will enable the manager to tell whether or not the department foreman is giving the proper attention to the men who need the most watching. The efficiency of the workmen can soon be determined; for if a man is a good one, the reports showing increases against him will be few and the necessary attention can be concentrated upon those men who have a large number of these reports against them. Form E—next page—filed by department and used in conjunction with the above file, will be instrumental in causing the shop management to exercise the best of care. Men are sensitive regarding errors made, and if compilations can be

"E"

RECORD OF REJECTED WORK

The following work has been rejected by me for the reasons checked

Description		Reasons	
Name of piece	ARM	Defective casting	
Piece number	A 40	Error in drawing	
Drawing number	2106 s	Error in pattern shop	
Material	C I.	Error in machine shop	✓
Order number	2460	Broken in handling	
Number rejected	2		

To Order Clerk-
Enter replace order to cover the number rejected, charging the time and material on the rejected work to Machine Dept. # 2.10- 10 hrs 300#

Remarks- Total Loss

Date 4-12-6 Signed Williams

FORM E. COMPARATIVE RECORD OF REJECTED WORK.

laid before them showing rejections for which they are to blame, it stands to reason that in their desire to retain their positions they will attempt to keep the rejections at as low a figure as possible. These same cards can also cover the return of materials due to errors and defects whether they have to be replaced or not.

Many other illustrations could be given to show the practical workings of this department, but the length of this article renders more elaboration inadvisable. Before closing, however, let us see what the possibilities of this department are if conducted along right lines. In the first place one man, under the supervision of but one man, is giving his whole time and attention to the work of collecting the numberless details of the business—the great advantage being that we have all the information in one place, all wound on one spool; and the result of arranging, classifying, and compiling these details is a statistical bureau containing valuable information concerning prime and burden costs, sales and lost sales, purchases, efficiency of salesmen, workmen, and the shop management, earnings, etc—all of which, properly analyzed, places in the hands of the executive the whip with which he can enforce the desired results. Back of this whip is the hand. Guiding this hand is the knowledge made possible by information which is "current history," and which has been properly analyzed under the best of conditions The only result possible is—Cost Reduction.

EDITORIAL COMMENT

A MOST commendable outcome of the exposition of safety devices and industrial hygiene, held in New York last winter by the American Institute of Social Service, has developed in the plans for the foundation of a permanent "Museum of Security." It may be said of many occupations, as Mr. Nixon says elsewhere in this number of the marine fire-room, that the frightful conditions "have been so long looked upon as necessary evils that the pitiable life . . receives but little attention." Those most constantly in contact with such conditions seem to become most imbued with the conviction that they are inevitable. Employees steeled to endurance pass easily into recklessness. Employers schooled to indifference descend to callousness. The age of brutality in works management has given place to one far more enlightened, but there are still superintendents, like the one recently quoted by Mr. Becker in these pages, who can meet the advocate of a safety device with the exclamation: "Hell! fingers don't cost us anything!"

To the majority of us, impressions received through the eye are the most vivid. Argument, description, statistics, are weak in comparison with concrete instance and object lesson. Herein lies the power of the museum. It convinces of the evil and at the same moment exhibits the remedy. It is a continuous educational force, limited in range at first, but constantly widening. We do not share the scepticism as to its value recently expressed by our excellent contemporary, *Engineering News*. We believe it will give new impetus to a tendency which has already received much attention and acceleration through articles published in this magazine—the movement for the betterment of industrial environment, for the "square deal" for the workman. It is a movement which, in our view, must get its force from the moral and intellectual conviction of the employer. It is he who, in the language of a recent public speaker, must "teach the worker to value his own life." The worker so taught will be a better, a safer, and a more responsible employee. No one need fear that such effort is mere visionary altruism. It is soundly utilitarian. The argument can hardly be put more concisely than it was by H. F. L. Orcutt, in his remarkable series of articles on machine-shop management published in this magazine eight years ago:

"First, last, and always should manufacturers remember that it is economy as well as humanity to plan factories 'in which human life is of more account than machinery'; into which human beings will not be driven by hunger, but attracted by superior hygienic surroundings—air, light, comfort—as well as by the most modern equipments for saving labor, increasing output, and raising the standard of workmanship and wages." In short, it pays.

* * *

A KINDRED effort, of more closely individualized purpose but of larger field, is that which is being actively pushed by the Committee on the Prevention of Tuberculosis of the Charity Organization Society of the city of New York. Their object is a systematic campaign of education, first to convince those who should be interested that the disease is preventable, and second to teach simple rules by which it may be avoided or its ravages may be checked. The annual "economic

waste" in the State of New York alone from this one cause is said to be 14,000 lives and $30,000,000. While some of the sources of origin concern the public at large, it is unfortunately true that others center peculiarly in certain defects too frequently characteristic of our manufacturing establishments; and that some such plants are breeding grounds for the disease, menacing not only their own workers but the whole community. In general the ideal conditions for resistance to tuberculosis are light, open air, and abundant nutrition. The literature of the committee points out how the most favorable conditions for the prevention of infection may be obtained by practical measures, and is well worth study. We believe it may be secured by application to Paul Kennaday, secretary.

* * *

"THE safety of society;" said Mr. Carnegie in his address at the dedicatory exercises of the new home of the United Engineering Society, "lies in the fact that in any enterprise for good there is always consolidation and co-operation," and this remark sounds the key-note of all the addresses delivered on that occasion. The union of the engineering societies was hailed as an event of remarkable significance, indicative of the beginning of an era of larger and greater engineering achievement in this country. The same speaker also made the statement, rather remarkable in view of the facts, that "all the engineering societies of America are really one band." It is doubtful, however, whether a consolidation of the various engineering societies is, at the present time, either desirable or possible. Since the separation of the societies devoted to special branches of the engineering profession from the parent stem, there has been no alteration in the industrial conditions which made separation advisable. There is today the same demand for the specialist, a demand which the passage of time has served only to intensify, and of whose cessation there are no present indications. At the same time, however, the interdependence of the various branches of the engineering profession has become more and more apparent. It is now fully recognized that the electrical engineer must have mechanical knowledge, that the mechanical engineer must be thoroughly familiar with the applications of electricity, and that the mining engineer must be prepared to apply, in his work, at least the fundamental principles of almost every branch of applied science. It is here that the strength of the United Engineering Society must lie; not in the attempted consolidation of the various branches, of special interests so diverse though interdependent, but in the increasing of facilities for free and full interchange of ideas. Co-operation, not consolidation, must be the basis upon which the Society is to attain to greatest usefulness and influence—co-operation in the advancement of engineering knowledge, in the maintenance of standards of professional ethics, and in the raising of the profession of engineering to its rightful place in the eyes of the world.

* * *

THE very large amount of work attending the preparation of Mr. C. U. Carpenter's article on the determination and introduction of "standard times" for machine-tool operations—the next installment in his current series—made it impossible to reduce the materials to final form in time for inclusion in this issue. The enforced interruption of one month, however, we believe will be compensated for by the value of the discussion which will be resumed in our June number, and we hope will be continued thereafter without further break.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE RAPID TRANSIT SYSTEMS OF LONDON.

FEATURES OF THE DEVELOPMENT OF TRANSPORTATION SYSTEMS WITHIN THE BUSINESS DISTRICT OF LONDON.

Engineering News.

OWING to the narrowness and crookedness of many of the streets and the dense congestion of traffic in the main thoroughfares, the question of transportation facilities within the city of London proper has been one of extreme difficulty and complexity. For a great many years, street railways were excluded from the main part of the city and were limited to operation in the suburban districts. In the business districts their place was taken by the cab and omnibus. Within recent years, however, the restrictions on street railways have been removed and a great development has taken place in transportation facilities in which motor omnibuses and electric railways, both surface and underground, have been the important factors. *Engineering News* recently published an article on the present condition of rapid transit service in London from which the following extracts are taken.

"The rapid development of the private motor carriage or automobile has been accompanied, in Europe, by an important development of motor omnibuses for public service, and in London there are now hundreds of these latter machines in use. The great majority of them are operated by gasoline engines, and are double-deck machines, with a spiral stairway from a large rear platform to the roof. A typical omnibus has seating accommodation for 16 inside (on longitudinal seats) and 18 outside (on transverse seats with a central gangway). The weight complete is 4¾ tons, and it is driven by a gasoline engine of 35 HP. One of the omnibus companies is operating several steam omnibuses of the Clarkson type, which were recently described at a meeting of the British Institution of Mechanical Engineers.

"In the Clarkson steam omnibus, the boiler is of a 'semi-flash' water-tube type, having a series of dished spiral coils connected together to form the equivalent of a continuous length of tube. The feed water enters at the top, and after reaching the bottom the water (or wet steam) is led to a coil directly over the fire, and then up to the final or superheating coil. The steam pressure is from 300 to 450 pounds, and the pyrometer (mounted in front of the driver) indicates a steam temperature of about 800 degrees F. The fuel is kerosene. A two-cylinder double-acting engine is used, having slide valves operated by the Joy valve gear; this drives the countershaft through a single set of spur gearing, and sprocket chains run from wheels on this shaft to sprockets on the rear driving wheels. The exhaust steam is condensed in a radiator placed in front of the machine and having vertical tubes, over which a stream of air is forced by a fan.

"The report of a Parliamentary committee appointed to investigate the conditions of vehicular traffic in London states that 520 motor omnibuses were licensed during the year 1905, and 400 of these carried 1,500,000 passengers per week. The first

machine of a given class is subject to inspection before the license is issued, but the report states that the duplicate machines should be similarly inspected, while when in service the omnibuses should be frequently and severely tested, especially in regard to the steering gear and the brakes. A legal speed limit of 12 miles an hour, actively enforced by the police, is also recommended. As to the skidding or side-slip of the machines, the report states that this is mainly due to 1, a greasy or slippery road surface; 2, the mechanical action of the differential gear in propelling the driving wheels unequally under certain conditions. The liability to side-slip is greatly increased by the needlessly high camber of many roads. The danger can only be avoided by the provision of good road surfaces, kept in proper condition, and by the substitution for the differential gear of a more efficient mechanism. The chief cause of noise and vibration is said to be unevenness of the road surfaces, and some reduction would result from the use of omnibuses of smaller capacity and decreased weight. The report points out that the police have authority to order off the street any licensed motor omnibus making an undue noise, causing a nuisance by the emission of smoke, or otherwise faulty. From January 1 to June 8, vehicles were stopped 114 times for weak springs and broken frames; but the committee considered that the police should more rigorously exercise their powers to remove offending vehicles off the streets. To prevent offensive exhaust, whether due to the presence in the exhaust gases of carbon monoxide or to smoke caused by overlubrication, it is recommended that automatic ignition and automatic lubrication be included in the specifications of motor vehicles. It is also suggested that there should be a switch within the conductor's reach by which the current for ignition purposes can be interrupted, thus stopping the engine in case of emergency.

"All the street railway lines in London were operated by horses until within a few years ago, when the London County Council began to acquire many of these lines and to convert them to electric traction. At the present time there are numerous long electric lines, and the work of rebuilding the old lines and introducing electric traction is proceeding rapidly. The conduit system is adopted in the city and more crowded districts, while the trolley system is used in the outlying districts."

The London County Council now operates some 60 miles of track. The first sections were laid entirely with short yokes carrying the slot rails only, but in later work the alternate yokes are extended to carry the track rails. The tracks are of standard gauge, and are usually 9 feet centre to centre. They are laid with grooved-girder, 105 pound rails, 7 inches high, of the British standard section. Two miles of side-slot conduit line have recently been built. The tracks are laid at one side of the roadway and in the same position across Westminster Bridge. The paving is of Australian wood blocks; but on some of the conduit lines in suburban districts granite blocks are used.

The London United Electric Tramways Company has 70 miles (single-track) of electric line on the overhead trolley system. This, like all the London work, is notable for the substantial character of the construction. The tracks are of standard gauge, 9 feet centre to centre, and are laid with 6½ inch, 92 pound, grooved rails of the British standard section. These lines also are paved with Australian wood blocks. Unusually heavy steel poles are used as the span wires are 23 feet above the rails to allow of the use of double-deck cars. The equipment consists entirely of double-deck, double-truck cars. These seat 30 persons inside and 44 outside. Each car has two 40 horse power motors, the power being supplied by 500-volt direct current from the Kingston sub-station of the London Underground Railway Company whose main power station at Chelsea supplies several of the underground lines.

"Most of the London street railways use double-deck cars, both for horse and electric traction, and in most cases they are mounted on two trucks. One important line, operated by the London County Council, has cars without the usual upper deck on account of running for some distance through a shallow subway under the streets and the Erith Urban Council uses single-truck, double-deck cars. The cars can as a rule pass curves of 30 feet radius.

"The first piece of underground railway in London was opened in 1863. The original system formed an irregular belt line, with numerous connection to main line railways and with a number of surface suburban extensions. This has been in operation for many years, and consists of arched tunnel and rectangular subway (cut and cover) construction kept as near to the surface as possible. The northern portion is owned by the Metropolitan Railway and the southern portion by the Metropolitan District Railway, but it is operated as one system, the trains of each company passing over both portions. It was originally operated by steam locomotives, but these have now been superseded by electric traction.

"For many years projects were promoted for underground lines traversing the district enclosed by the original system, but none of these materialized, until a few years ago the Central London Railway was authorized to build and successfully completed an east and west diametrical line. This was a deep-level tubular tunnel line, but as a type it had been preceded by the City & South London Railway and the Waterloo & City Railway, each extending under the Thames from the central part of the city southward. Both have been succeeded by a number of other lines, several of which have been completed recently, so that there is now a network of deep level 'tube' lines, all operated by electricity. Unfortunately, the lines have not been laid out as part of a comprehensive scheme, but each one has been promoted by an independent concern with a view to a certain route or direction of traffic, so that the system is not as comprehensive or homogeneous as it might have been. Connections are made by passages, shafts, etc., at several points where the lines cross, but in many cases these involve long walks on level or inclined subways, and the climbing of spiral stairways. Elevators are used at the stations, but for some reason they are often placed at a distance from and do not reach the level of the station, so that passengers have to use a combination of elevators, stairs and passages in getting from the street to the platform. The elevators are of insufficient capacity to promptly handle the rush traffic, and streams of people then use the stairways to the surface. In several cases also, the passages are narrow, or their arrangement is awkward, so that the streams of passengers going to and from the trains are congested or 'throttled,' or even conflict with one another. Long underground passages or subways lead from the stations to important points (such as railway terminal, etc.) so that passengers can reach them without crossing the streets. At 'The Bank,' where numerous streets and lines of traffic center, there is a circular subway just below the street level, with stairways to the several streets, so that the general public as well as the railway passengers can get from point to point without crossing the streets. In the center of this subway is the entrance to the shaft of the terminal station of the Central London Railway, with connections to stations of other underground lines.

"The lines of the Metropolitan Railway and Metropolitan District Railway are at present in a transitory state, being converted from steam to electric traction, and have three systems of traction now in use on the same tracks: 1, the electric trains of the two companies; 2, suburban trains from other lines hauled by steam locomotives; 3, suburban trains from other lines which detach their steam locomotives at the connection with the 'underground,' and are hauled over the latter by electric locomotives. Eventually all the steam locomotives will be abandoned for tunnel service, except perhaps for the freight trains handled by some of the main line railways over parts of the underground lines to reach local terminals in the city. Some of the regular trains of the Metropolitan Railway consist of seven double-truck compartment cars, each of the two end cars having four motors of 200 horse power. The motor cars also have baggage compartments. The trains have the Sprague multiple-unit control system, and can be run at 45 miles an hour, the average schedule speed (including stops) being 16 miles per hour. The motor cars weigh about 38 tons each and the trail cars 10 tons each, with a total weight of 172 gross tons for the train, which is 290 feet long."

Besides the original Metropolitan lines, there are seven modern "tube" railways of greater or less importance radiating from

the centre of the city and running to outlying suburbs or to the more important railway stations. These are all operated electrically.

"The ventilation is not satisfactory on any of the tube lines, the best conditions being in the large tunnels of the Great Northern and City Railway. In all the others (and even in these to some extent) headache and an oppressive feeling in the chest and head are liable to be experienced, sometimes to a very unpleasant extent. On all these lines the problem is to secure efficient ventilation without producing currents so strong as to blow passengers' hats off or severe drafts that will cause passengers to take cold. The lighting of the cars is also very unsatisfactory as a rule; in general it is dim, and in all cases subject to fluctuations which are very trying. The cars on different lines have side seats, cross seats, or a combination of both as in the cars of American rapid transit lines. In very few of them can the windows be opened, as open windows would be dangerous with the small clearance between the car and the side of the tunnel. In a few trains the cars are divided into compartments, but as a rule they are of the American type, with end doors. In some cases, side doors are also placed at the middle of the car. A unique arrangement on the City and South London Railway consists in placing a single platform between each pair of cars, giving one wide opening for passage to or from the station platform. As a rule there is only one class, but on some of the lines the trains have first-class and second-class cars. One excellent feature is the cleanliness of the cars; there is practically no expectoration in the ordinary cars, and very little in the smoking cars, the latter even having 'anti-spitting' signs. Tickets are issued to passengers, and given up to collectors as passengers leave the station platforms at their destinations. On the Central London Railway, with a uniform 4-ct. fare, the tickets are dropped into a chopping box before the passengers go to the trains."

THE EVOLUTION OF THE MOTOR BUS.

A DISCUSSION OF THE IMPROVEMENTS IN CONSTRUCTION AND OPERATION NECESSARY TO MAKE THE MOTOR OMNIBUS A COMMERCIAL SUCCESS.

W. Worby Beaumont—Society of Motor Omnibus Engineers.

AS remarked in the preceding review, the motor omnibus has become an important factor in the transportation systems of European cities. In London, owing to the peculiar difficulties of surface electric traction, systems of motor omnibus transportation have probably reached their highest development and there are now about 900 of these vehicles in active use. Marked improvements have been made in construction and operation; the objectionable elements of smoky exhaust and incessant noise of operation have been eliminated to a great extent, but much further development is necessary before the motor omnibus can be called a complete commercial success. Mr. Worby Beaumont's recent paper before the Society of Motor Omnibus Engineers indicates some of the lines along which such development must take place.

Setting himself to answer the question: "What is wrong with the better types of motor omnibus?" Mr. Beaumont replies as follows:

Firstly, more attention must be given to the requirements of the motor omnibus as an intricate machine. Secondly, and to this end, more attention must be given to the requirements of the motor omnibus engineers, who have the responsibility of maintaining the omnibuses in a fit condition to be kept on the road. Thirdly, the maintenance of the motor omnibus, being placed under the superintendence and guidance of trustworthy and competent motor 'bus engineers, those engineers must be allowed to be the best judges of the requirements of their department. Fourthly, the judgment of the motor 'bus engineer, who is responsible for the maintenance of the motor 'bus in running order, must be final as to that condition, and not that of the traffic manager. Fifthly, the running of a number of motor 'buses means the maintenance of a lot of machinery.

"This last-named requirement, according to the number of motor omnibuses, means an engineering works with good equipment of tools of various kinds, and more or less in number, and workshops of proper construction and of character suitable to the kind of work which has to be done in them: there should be workshops and appliances, which must not be inferior to those of engineering works, wherein are made gas engines, petrol engines, and the highest class of millwright machinery. This may seem to be a call for a very large expenditure, but, considered with reference to a number of omnibuses, and with the imperative necessity for thoroughly good and comprehensive maintenance work, that expenditure is not only necessary, but is the means of *making*, because of saving, money.

"The present motor omnibus, of the better kinds, is a satisfactory vehicle, if those who use them could be persuaded that it is better suited for a moderate speed than for racing. The motor omnibus which, with its load, weighs 6¼ tons, running, as it often does, at 14 to 18 miles per hour, especially when running home at 1 o'clock at night on some of the lines, reminds one of an elephant bought by an ill-advised purchaser for the purpose of running in competition with an Arab steed, and one of the first necessities in development is not change in construction, except in so far as gear ratios are concerned, but in the use of the present vehicle with regard to the speed at which it is forced to run. It would be good policy, so to arrange the engine and gear of a motor omnibus, that the driver could not, under any circumstances for London use, exceed, approximately, 12 miles per hour, the gearing being also so arranged that he could, under the conditions of traffic running, maintain a high average speed, so that little time would be lost on such hills as are mostly met with in London, the power already common on these vehicles being sufficient for the purpose without going to the high powers which have been fitted to some. It may be said that a maximum speed of about 12 miles per hour is insufficient, but this would not be the case, and the statement could only be supported at the present time because so many of the omnibuses are running at high speeds, which are unnecessary, uneconomical, and suicidal. It is true that the very high speeds please some people, even on bad roads, but that which is commercially possible must be considered by the owners of things purchased for commercial purposes, and it will be much better so to work motor omnibuses now, as to enable them to be kept on the streets, than to run the risk of commercial failure, and of opposition by the many to whom they are, as at present run, a positive and real nuisance.

"The high speed, of which I have complained, is not only the cause of the troubles already referred to, but it enables the omnibuses to be run 120 miles and more per day in the 16 or 17 hours which is its day's work. There are thus only left the few hours, from 12 or 1 o'clock at night to the very early hour in the morning, at which the 'bus must leave the yard. In these few and unsatisfactory hours of the 24, all the many hundreds of parts have to be or should be, carefully looked over by competent men, so that not only is that which is obvious attended to, but so that the defect or looseness which is not obvious may be discovered. The more completely this is done the fewer will ultimately be the necessary renewals, and the less the labour in maintaining a thorough inspection. If the omnibuses run only 90 to 100 miles per day, or even less on some of the very bad roads, no more time in the garage would be obtainable, but the present heavy cost of repairs and renewals might be lessened materially. Further, it must be urged that a thorough daylight examination, and overhaul, should be carried out once every week, and every garage should be provided with a satisfactory, simple, body-lifting gear, so that the chassis may, from time to time, be made ready for a complete, unfettered overhaul. At present very few omnibus companies have sufficient stand-by vehicles; but, ultimately, it will be found necessary, considering the large number of hours per day that every 'bus runs, to have, at least, a stand-by stud of 10 per cent.

"Few who are careful in arriving at a conclusion would like to say much with regard to the oft-repeated question of steam *versus* the internal-combustion engine for motor omnibuses, though I think that few will agree with the opinion, sometimes ex-

pressed, that the internal-combustion motor is not likely to be very much improved, either in thermal or mechanical efficiency, or in its adaptability to the whole of the requirements of the motor omnibus. It is now a very few years since the present type of petrol engine was harnessed in the hard, commercial omnibus field of work, and already great improvements have been made in its adaptability to circumstances in its flexibility and quietness of running, and, in fact, in most particulars, except with regard to simplicity and accessibility. There are some exceptions, even to this, wherein automatic valves are still used, and the whole engine may be readily detached from its seating, and its pipe connections may be uncoupled and recoupled in as little time as I am taking to mention the operations. There are some engines, it is true, in which infinite pains have been taken to introduce as many moving parts and connections as could, anyhow, by any number of drawings, be conveyed to the intelligence and perseverance of those who have had to make them; but the merit of this form of ingenuity has, fortunately, not been discovered by all makers. Judging by the greater number of omnibuses in use at the present time, it is not yet understood that it is possible so to design the combination known as a chassis that the whole lot of the machinery could be taken down and reinstated by a small number of men in four or five hours, and that the gear-box and its connections may be so arranged that those responsible for the running of omnibuses would feel encouraged to make sure of the satisfactory condition of everything by the taking down and re-instating, which can be done in a couple of hours, rather than to leave things until the unsatisfactory condition is proved, either in the streets, or by finding in the garage that complete renewal is required where, by better arrangements, a mere adjustment might have sufficed.

"It is, perhaps, early to expect it, but it does appear to be desirable that the engines should be provided with a cooling system which does not need the aid of a miniature pumping station, or even of a tiny toy fan. It is also conceivable that the engine might be so made, connected, and mounted, that in five minutes all necessary disconnections could be effected, and the engine turned aside or lifted out of the chassis, for examinations and adjustments, as comfortably as the watchmaker has his watch on his table. It is, further, conceivable that it is not beyond the capability of the designer to carry the engine in the frame, and so to connect the gear-box and all the machinery, not only that the inevitable flexure of the frame may occur without twisting crank-chamber brackets off the chamber, or throwing all sorts of ambiguous stresses on the various parts of machinery and bearings, but so that flexibility in the frame may be recognised, instead of fought against, by unsuccessful attempts at complete rigidity."

ELECTRIFICATION OF THE SIMPLON TUNNEL RAILWAY.

THE USE OF THREE-PHASE ALTERNATING CURRENT IN ELECTRIC-RAILWAY OPERATION.

H. Rupp—Zeitschrift des Vereines Deutscher Ingenieure.

ANOTHER line of communication between Italy and Switzerland was opened up last year by the completion of the tunnel, twelve miles long, through the Simplon, one of those great masses that form the natural boundary between the two countries, and over whose celebrated pass so many Alpine tourists have made the journey between Brieg and Domo D'Ossola on foot or by "diligence." At the time the construction of the Simplon tunnel was begun, it was intended to employ steam locomotives, but the advances made in the art of heavy electric railroad operation during the past three years induced the engineers in charge to adopt electricity for the motive power, especially after the success attained in the operation of the Valtellina railway in Northern Italy. This line is worked by locomotives taking three-phase alternating current, and the results were, from its inception, so satisfactory that it was decided to use the same system (that designed by Ganz and Company, Budapest), for the Simplon line. An illustrated de-

scription of the line and the equipment appears in this issue, on pages 195 *et seq.* The additional data here presented are taken from the *Zeitschrift des Vereines Deutscher Ingenieure.*

The work to be done by locomotives on this line is not easy. The grades through the tunnel are steep, and an average speed of from 40 to 46 miles per hour must be maintained with trains weighing 250 tons. For supplying power, streams were available near each end of the tunnel, the river Rhone at the north end and the Diveria, a small tributary of the Tosa, at the south end. Hence, two power houses were built. That at Brieg, on the Rhone, contains two Escher, Wyss and Company turbines developing 600 horse power each at 160 revolutions per minute under 148 feet head of water. These drive the generators, built by Brown, Boveri and Company, which develop 1,200 horse power in three-phase current at 3,000 volts and 16 periods per second. At the south end of the tunnel, at Iselle, the Tosa river affords 459 feet of fall, and here two Piccard, Pictet and Company turbines are installed which run at 960 revolutions per minute and afford 750 horse power each. The generators at these two stations are designed for a 20 per cent. overload, so that their combined output is about 3,100 horse power.

The three-phase current is conducted by two overhead wires supported by span wires stretched between side poles up to the mouth of the tunnel. There are two pairs of overhead conductors in the tunnel, each wire being 0.354 inch in diameter. The wires are hung from insulators fastened to transverse steel rods at the ends of which are insulating blocks anchored to the walls of the tunnel. The use of two overhead conductors is unavoidable in the three-phase system, but each conductor being in itself of small cross section and light weight per unit of length, the maintenance of the two is a simple matter, and breakdowns are said to be very infrequent.

The locomotive carries two pairs of trolleys, one pair for operating in each direction. These are of the sliding bow type, and have a very slight effect on the wire as compared with a trolley wheel. The locomotive itself is interesting as exhibiting a type developed not only for these particular conditions, but which may become general in Europe for operating on either single or polyphase electric systems. It is mounted on three pairs of driving wheels and a two-wheel truck under each end gives the necessary flexibility to the wheel base to enable it to take curves easily. The total length of the locomotive over the buffers is 39 feet 10 inches, and its total wheel base 31 feet 10 inches. It has two motors, rated at 450 horse power each, but built for such a margin of overload capacity that the two can develop 1,900 horse power, without danger of injury. One of these motors is mounted between the first and second, and the other between the second and third, driving axles. Each is provided with a shaft, on the end of which is a crank driving the wheels by means of connecting and side rods. By this arrangement the weight of the motors is carried to best advantage, the connection between them and the driving wheels is somewhat flexible, and the two motors distribute their power uniformly to the three axles.

The cranks are made with a heavy counterbalancing segment, and the main and side rods are of I section in accordance with steam locomotive practice in both the United States and Europe. The driving wheels are 64½ inches in diameter and spaced about 8 feet apart, center to center, making the rigid wheel base quite short, 16 feet ⅞ inch. These three pairs of driving wheels carry a load of 92,400 pounds, while the total weight of the engine is 136,400 pounds. The cab is built on the frames, midway between the ends, with hoods sloping down toward the buffers, and containing the rheostats, transformers, air reservoirs, etc. Air is largely employed as an auxiliary, since the engine is equipped with Westinghouse brakes, pneumatic whistle, sanding apparatus and trolley raising device.

Since each overhead conductor is at any moment, in a distinct phase of the wave of alternating current, two trolleys must be employed, insulated from each other, and, instead of using a revolvable trolley base as is common on street cars, a separate set of current collectors is used for running in either direction. This makes a somewhat complicated arrangement of cir-

cuits and does not improve the otherwise satisfactory appearance of the locomotive. It is said to operate very well, however. The engineers of the Swiss and Italian governments imposed very rigid specifications upon the builders of these locomotives. Among other things, the motors were obliged to stand an insulation resistance test of 15,000 volts, alternating, for fifteen minutes.

The track rails are not bonded, but the six bolt angle splices are carefully fitted, and set up very tight against the head and base of the rail. The rail itself is of Goliath section, 5¾ inches high, and for each length of 32 feet 9⅝ inches, tests to a resistance of 0.000257 ohm at 32 degrees F. When the tunnel was first opened for traffic, steam locomotives weighing 103 tons, the standard on the Italian and Swiss railways, were employed. The electric locomotives that have now replaced them, have greater tractive power and weigh only 62 tons.

THE FOUR-CYLINDER LOCOMOTIVE IN GREAT BRITAIN.

TYPES OF FOUR-CYLINDER LOCOMOTIVES RECENTLY PUT IN SERVICE ON BRITISH RAILWAYS.

Chas. S. Lake—Mechanical Engineer.

THE four-cylinder locomotive has occupied an established position on European railroads for some time and, within the past few years, several railroads in the United States, notably the Baltimore and Ohio, and the Atchison, Topeka and Santa Fe, have introduced them on their lines. In Great Britain, there has been a disposition to regard the four-cylinder locomotive unfavorably, but this prejudice is gradually disappearing and several locomotives of this type have lately been placed in service on British railroads. An article by Mr. Chas. S. Lake in a recent number of the *Mechanical Engineer* describes the general features of the locomotives that have been evolved by British designers.

"Abroad if we except in some measure the United States, the 4-cylinder compound has an established position. It is accepted as the best type for working all classes of traffic, and variations between the locomotives of one country and those of another are mostly confined to the design and arrangement of essential parts, and do not embrace the main principle upon which the engines are constructed and worked. Antipathy to the 4-cylinder arrangement in Great Britain at first centred in the alleged unnecessary complication of details, then it was the compounding of the cylinders which was wrong, and finally, when the 4-cylinder simple locomotive made its appearance in a modern form, the difficulty which would be encountered in maintaining a sufficient supply of high-pressure steam was put forward and urged as a drawback to the notion.

"These and other objections have for the most part disappeared as the result of the determined efforts made on a few British railways, during quite recent years, to establish the 4-cylinder locomotive as one of the standards of mechanical engineering practice on the railways of the country. It is, of course, the duty—and also the principal object—of every locomotive superintendent to produce an engine which shall give the best results in working, having regard to economy in costs of manufacture, working, and maintenance. The cheapest type of engine to build is undoubtedly that which is most simple and straightforward in design, and if this engine will do all that is required of it, not on any specially selected occasion, but in everyday working under varying conditions of weather and load, hauling the traffic it was designed to haul, and doing the work with reasonable regard to economy in fuel consumption, then there is nothing more to be desired. The engine is in every way satisfactory, and to replace it by another, possibly of more modern construction but infinitely more costly to build and maintain, would be false policy, and quite indefensible. There is, however, a further aspect of the matter to be considered. Locomotives are not built in this country, as they are in America, on the principle of 'a short life and a hard one'; a few years of ultra strenuosity and then to the scrap heap, to make way for newer designs incorporat-

ing ideas as yet unformed when the earlier engine was built. They are constructed with the idea of many years of useful service being obtained from them before being finally broken up. The most careful and accurately fitted work is put into them, and only the highest quality materials are employed in their manufacture. This being so, it would seem to have become increasingly important, when designing locomotives for maximum duty on the main line, to adopt measures for providing the engine not only with a margin of power sufficient to enable it to cope with any chance difficulty when traffic is, either expectedly or unexpectedly, heavier than usual, but also to provide a reserve of capability for meeting future needs when, if the present rate of evolution is maintained, heavier train loads and more severe traffic conditions generally will have become the rule. . . . . .

"Apart from the question of working principle, there have to be decided such matters as cylinder disposition and wheel arrangement, and in four-cylinder locomotives these are of added importance, for they influence to a very great extent the whole design. Some engineers prefer to divide the cylinders and valve gears, arranging them for driving different axles, whilst others adopt the method of placing all four cylinders in line below the smokebox generally, although by no means always, for driving the same axle. The latter plan, so far as it relates to the cylinders, has the advantage in compound locomotives of shortening the steam passages between the high-pressure and low-pressure cylinders, and whether in compound or non-compound engines it allows of a simplified arrangement of the valve gearing in which only two sets of gear are employed for working the four steam distributing valves.

"Within the as yet restricted limitations of British practice in designing four-cylinder locomotives there are to be found examples of both cylinder and valve gear arrangements, and latterly the divided cylinder method has been introduced in conjunction with the plan of only two sets of gear for the four cylinders.

"This is on the Great Western Railway. The engine is of the Atlantic, 4-4-2, type, with four simple cylinders, of which the inside pair are carried forward of the smokebox and drive the crank axle of the leading coupled wheels, whilst the outside cylinders are located at the rear of the bogie centre, in which position they drive the second pair of coupled wheels.

"They are not placed altogether behind the bogie, as in the de Glehn compounds and other engines, but centrally with the rear bogie wheels, with their steam chests above them. The valve gearing is of the Walschaert type, and the valve of the inside cylinder only is connected directly to the gear, the outside valve being operated through a cross lever having a crosshead connection on the inside and a jointed connection to the outside valve stem. The inside valve receives motion in the ordinary manner from its rear end, but the outside valve is reciprocated from the forward end where, as before remarked, the spindle connects with the cross lever from the inside motion. This is the first instance in this country of a 4-cylinder locomotive having divided cylinders and only two valve mechanisms for the four valves.

"The plan of setting the cylinders to drive different axles has the advantage of distributing the working stresses over two axles instead of concentrating them in one, and if this can be successfully accomplished whilst evading the necessity of employing four valve gears it would be worthy of close attention. On the Great Northern Railway there are two four-cylinder compound locomotives and one non-compound at work, and one of the compounds as well as the simple engine has its cylinders arranged in line below the smokebox. Beyond this fact, however, the two locomotives are wholly dissimilar. The compound drives on two axles, but the four connecting rods of the simple engine all drive the leading coupled wheels.

"This latter engine began its career with two sets of Stephenson link motion only, but it has now been running for some time with independent gear for each cylinder, viz., Walschaert's for the outside and link motion for the inside cylinders. The same arrangement is applied to the Doncaster-built compound, but the other 4-cylinder compound on the same railway, built by the Vulcan Foundry Company, has divided cylinders and valve gears as adopted by de

Glehn and other engineers to meet the same conditions.

"The latest express passenger locomotives designed by the chief mechanical engineer of the North-eastern Railway have four cylinders in line and only two sets of gear, and this is proving very satisfactory. On the other hand, it is certain that the London and North-western Railway has greatly improved the Webb system 4-cylinder compound express locomotives by replacing the original 2-gear arrangement by a separate set of gear for each cylinder. These seemingly conflicting results are explained partly by the difference existing between the actual design and methods of applying the gear, which methods vary considerably, and being directly associated with the distribution of steam to the cylinders, play an all-important part in the general efficiency of the locomotive. There is no justification at the present for saying that any one combination of cylinder and valve-gear arrangements possesses substantial advantages over others.

"Those who have much occasion to travel on the railways of this country for the purpose of noting the work performed by locomotives, and especially those whose duties or privilege give them access to the footplate under actual running conditions, can hardly have failed to come to the conclusion that the time has now arrived when the four-cylinder engine ought to be given a thorough and impartial trial, and present indications are in favor of the assumption that this will be done. Even then, however, it is obvious that only a new phase of the simple *versus* compound controversy will have been entered upon, as British engineers, or the majority of them, appear to be still unconvinced of the merits of the latter in spite of all that has been and is being done abroad."

TRANSPORTATION EXHIBITS AT THE MILAN EXPOSITION.

TYPES OF ELECTRIC LOCOMOTIVES AND APPLIANCES WHICH SHOW THE TREND OF EUROPEAN DESIGN.

A. Zweiling—Zeitschrift des Vereines Deutscher Ingenieure.

AT the Milan International Exposition of 1906, a number of exhibits of both steam and electric locomotives were shown which were very complete, and "up to date," as representing current European practice for both steam and electric roads. Reference has been made in former issues of this magazine, to the development of steam locomotive design in Europe, and it has been pointed out that the locomotives shown at Milan last year were almost without exception compounds, mainly of the four-cylinder type. The majority were fitted with superheaters and they showed in these two details of design, the most advanced ideas thus far put into practice. The electric railway exhibits at Milan were described by Herr Zweiling in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure.*

As in the United States, no one particular system of either direct or alternating current has been found in Europe to be the best for all conditions. Consequently, there were shown at the Exposition, motors for direct, for single-phase alternating and for three-phase alternating current, together with the controlling apparatus and brake systems now in use on heavy cars and locomotives. In Italy, there is a line from Milan to Porto Ceresio, 81 miles long, operated by large, double-truck cars. These motor cars seat about 42 passengers, and their appearance closely resembles cars used for the same kind of service in the United States. One of these cars was shown at Milan. It is mounted on two four-wheel trucks, each truck fitted with two 160 horse power, 600 volt, direct-current motors. The cars now in use have been equipped partly with General Electric, and partly with Thomson-Houston motors, and they are designed for a maximum speed of 56 miles per hour, and a normal speed of 37 miles per hour. The cars are fitted with shoes for collecting current from a third rail. Another, but smaller motor car was shown for a Hungarian road, also equipped with direct-current motors. These two are fairly representative of direct-current motor-car practice in Europe at the present time.

Where alternating current is adopted, the requirements to be met have led to the development of a locomotive peculiar to Europe. One of the three-phase, 3,000 volt, alternating-current locomotives built for the Valtellina railway was shown at Milan. This is almost a duplicate of those built for the Simplon Tunnel railway which are described in a review in this number. They are equipped with alternating-current motors, taking current at 3,000 volts, and are built with cranks on the motor shafts which operate the driving wheels through connecting and side rods. They can develop about 1,900 horse power at slow speed, and are designed to haul trains of 250 tons weight, on a level, at 47 miles per hour.

Another three-phase locomotive exhibited was that built by the Siemens and Halske Company for the Berlin-Zossen high speed tests, and built to work on three-phase current at 10,000 volts, transforming, of course, to a lower voltage at the motors. It has been pointed out that the economy attained by the use of such high-tension current is largely offset by the enormous weight of the transformers which must be installed on a 1,000 horse power car. As showing, however, what can be done in the direction of high speed with very light trains, such systems are well worthy of careful, detailed study.

Single-phase alternating-current motor cars were also well represented. One of these cars, that in use on the Vienna-Baden interurban line, is a double-truck car, driven by compensated single-phase alternating-current motors for the purpose of making it interchangeable with the Vienna city tramway cars operating on direct current. Another single-phase car shown was for the Blankenese-Ohlsdorf suburban line in Prussia. This car does not present any unusual features, but is much larger and has more powerful motors than the Vienna-Baden car. While conclusions based on general principles are apt to be erroneous, it nevertheless seems that the three-phase alternating system is becoming the system most favored by European engineers. Aside from the small amount of copper required for the transmission of a given quantity of energy, the motor possesses the advantage that in running down grade, or coasting, it acts as a generator, and feeds current into the line.

Among the novel features of the Exposition were a passenger motor bus and a freight carrying wagon or dray, driven by electric motors. These are steered by hand, but draw their energy from an overhead wire through a long, flexible pole. These vehicles have been called "trackless trolleys," and for operation along highways and city streets, seem to possess some merit. Both are equipped with direct-current motors. A convenient adjunct to an electric railway shown at the exposition is a tower wagon for making repairs to overhead wires. It has an extension ladder, with a platform at the top large enough for two men to stand while making repairs and to hold the necessary tools. It can be moved from place to place at any time, being fitted with a standard Daimler 20 horse power gasoline motor, thus giving ease and rapidity of motion and transference to any place on the line to be repaired.

Cars were exhibited with revolving snow sweepers, similar in general features, but smaller than those in use in American cities. A flanger car, pulled by a regular motor car, was a rather new departure, as the flangers were attached to a car separate from the snow sweeper car. Air brakes for electric cars and locomotives were also on exhibition, and for these the motor compressors employed are very similar to the American types of such devices. For track work, such as drilling holes for rail bonds, cleaning rail ends by sand blast before welding, and similar work, a set of portabe machine tools was shown, all supplied with power from a movable power plant. Two of these plants were exhibited; one had a 50 horse power gasoline engine driving a dynamo which supplied current to the motor-driven machine tools referred to; the other had a boiler and steam engine driving the dynamo. For machine shops there was exhibited an air compressor, motor driven, mounted on a three-wheeled truck, which could be dragged about anywhere in the shop. The motor is connected to the nearest outlet on the power circuit of the shop, and a hose attached to the reservoir supplied by the compressor, feeds pneumatic tools at any point.

ELECTROLYTIC CORROSION OF IRON AND STEEL IN CONCRETE.

RESULTS OF EXPERIMENTS TO DETERMINE THE AMOUNT OF CURRENT AND THE TIME NECESSARY TO PRODUCE CORROSION IN METALS IMBEDDED IN CONCRETE.

A. A. Knudson—American Institute of Electrical Engineers.

IT has long been known that cement or concrete will effectively protect steel structures against the corrosive and rusting action of both salt and fresh water, but its effectiveness as an insulator against stray earth currents has always been in doubt. The question is one of very great importance and Mr. A. A. Knudson's recent paper before the American Institute of Electrical Engineers presents some very valuable data as to the time and current necessary to produce corrosion of iron imbedded in concrete, by electrolytic action.

Mr. Knudson began his experiments in March, 1903. Blocks of concrete, consisting of equal parts of Portland cement and sand, were made in ordinary metal pails slightly larger at the top than at the bottom. In the centre of each block was placed a 2-inch wrought iron pipe which was buried in the concrete to a depth of about 8 inches. The blocks when finished were 12½ inches high, 10 inches in diameter at the top and 8 inches in diameter at the bottom. During the tests the blocks were immersed in water to a depth of about 10 inches and were supported on wooden blocks. A binding post was attached to the projecting end of the pipe; the current, after passing through the block was led off through a 5 inch by 6 inch plate immersed in the water.

In the first series of tests, three blocks were used. One, for the purpose of comparison, was immersed in sea water without any current being passed through it. The others, one of which was immersed in salt and the other in fresh water, were connected in series and a current of 0.1 ampere was kept continuously flowing through them.

"At the conclusion of this test which extended over thirty days' time, the blocks were removed, and after allowing them to dry they were broken open. It was found to be quite easy to break open the blocks through which the current had passed as they had already become cracked. The block which had not been subjected to electrolysis was broken with the greatest difficulty. The former showed on their interior strong evidences of electrolytic action in the form of what was apparently a deposit of iron rust extending from the pipe toward the outside of the block. Along certain lines which acted like lines of cleavage, the cement was found to be softened so that it could readily be cut or scraped with a knife. This softening was such that the point of the blade of a pocket knife could be inserted into it far enough so that the knife was supported in an upright position. The pipes enclosed in these blocks were found to be considerably corroded. A portion of the scale on the corroded parts of these pipes was removed and the pipes were weighed. The pipe in the first-mentioned block was as bright as a new pipe and the concrete showed no evidences of a deposit of iron rust. Weighing of the pipes had been made before casting them in the blocks. Weighings made at the conclusion of the experiment showed losses in the pipes which had been subjected to electrolytic action amounting to 1.55 ounces in the case of the block immersed in fresh water and 1.1 ounces in that immersed in salt water.

"The results of these experiments seemed so important that it was thought best before drawing conclusions to have the tests repeated, and therefore another set of experiments similar to the first, was made to see how the data would compare." This second series of tests was carried out on exactly the same lines as the first except that a different brand of cement was used and the results obtained were very similar and, if anything, more pronounced.

"These tests and experiments go to show that only a small fraction of an ampere is necessary to cause electrolytic action. The element of time being always with us, it is only necessary where electric currents are present of sufficient voltage in the proper direction, to cause even a very small amount of current to pass that will in time cause corrosion upon interior steel struc-

tures, whether placed in concrete, brick, or in granite masonry. It is not expected, however, that large granite piers would develop cracks, but electrolysis to interior steel work and to bridge anchorages may go on just the same. Cracks may develop, however, in concrete piers of small bridges, such as those which cross creeks or canals.

"By way of a practical illustration, there is a bridge in this city (New York) of this description over the Gowanus Canal, South Brooklyn, at Hamilton Avenue. A portion of the Bridge Commissioner's report ending June 30, 1906, referring to this bridge, is as follows:

"'Since construction the foundation walls of this bridge have developed some rather serious cracks, occurring on both sides of the canal, and there has been a movement of the walls towards the centre of the canal. During the last three months this movement has amounted to half an inch. Previously the movement totalled about three and one-half inches. From October to March there was practically no movement. A continuation of this movement for several inches more will result in the necessity of alterations in the centre of the leaves, as they will interfere before the bridge can be fully closed.'

"With a view of ascertaining the electrical conditions, we have made a few tests at this bridge. The voltmeter readings show the steel structure to be positive to the canal, positive to water-mains in the street, and positive to the trolley-rails on the bridge, ranging from 0.5 to 1.5 volts. These readings were taken when the car-traffic was light. Some of the cracks on the concrete had been plastered over, but others were quite visible. The tests indicate that the trolley tracks on the bridge are in connection with the steel structure. Tests were also made on another bridge of the same construction a little further north over the same canal, at Ninth Street. The readings here were exactly the reverse of those found at the Hamilton Avenue Bridge, the structure being negative to canal, to water-mains and tracks. There were no visible cracks in the concrete of either foundation. Although the cracks in the concrete of the Hamilton Avenue Bridge are attributed to other causes in the Commissioner's report, we believe these tests and observations point strongly to electrolytic action from trolley currents as being the true cause. This seems to us the more reasonable cause for these cracks, in view of the results of our laboratory experiments just described. Ordinary care would suggest that costly structures of this kind in this or other cities should be periodically inspected for evidence of electrolytic action upon the interior steel work, especially if located contiguous to water, or in the vicinity of electric railways or *railway power stations* as in the case just cited. Furthermore, this question should be carefully considered when such structures are planned, tests made at locations of proposed bridges or other structures, to ascertain the electrical conditions and the possibilities of injury due to electrolysis from stray currents.

"This question of electrolytic corrosion of interior steel in the construction of high buildings, however, has not been entirely neglected. There is at least one case, that of the *New York Times* Building, where provision has been made in advance as a protection. In the Building Supplement, issued by that paper, dated January 1st, 1905, an interesting description is given in detail of the entire construction of that building. The following extract, referring to electrolysis, will be of interest:

"'The danger that in the case of the steel frame, rust and the disintegration of electrolysis would hasten the process of dissolution so much as to make structures of this kind prematurely unsafe through the destruction of their supports, was recognized in time to permit of ample safeguarding in the case of the steel frame of the Times Building. It is axiomatic that columns to which moisture has no access will not be impaired by rusting, and that those effectually insulated from vagrant electrical currents will not be affected by electrolysis. The first consideration was to keep the basements dry. Hence the thorough waterproofing and draining of the retaining walls already described, which was carried under the floor of the press room, occupying the great area of the sub-basement. As a further safeguard, all the steel members up to the street level are incased in Portland cement mortar, to the minimum thickness of three-fourths of an inch.

This is effectual protection against rust deterioration. Under these conditions electrolytic disintegration is deemed impossible, but the probability of its occurrence in even microscopic degree is rendered still further remote by as perfect insulation as can be provided. There is sufficient grounding to relieve any electrical tension which may exist in any part of the steel frame by drawing off the current at points where electrolytic action cannot be set up.'

"This is the first instance we have noticed where a large corporation has recognized this danger and has taken steps beforehand to avoid it. The protection of steel structures already constructed, however, is a different matter. While plans may be made to provide insulating methods and water-proofings before construction, it is not easy to prevent corrosive action, when the conditions are favorable, after construction.

"From these laboratory experiments, as well as observations in practice, we draw the following conclusions:

1. Steel structures are well preserved from ordinary corrosion by concrete if placed either in salt or fresh water.

2. If but a small fraction of an ampere of electricity passes from an interior metallic column or structure into concrete or masonry as usually made, there will be corrosion of the metal and disintegration of the concrete or masonry.

3. Structures of steel in concrete that are subject to sea water are in more danger from electrolytic action than those in fresh water, by reason of the lower resistance of concrete in sea water as shown by the laboratory experiments.

4. In no sense can concrete be considered an insulator, and as shown it is from all appearances, just as good an electrolyte as any of the soils found in the earth."

REINFORCED-CONCRETE HIGHWAY BRIDGES IN GERMANY.

EXAMPLES OF RECENT DESIGNS OF ARCH BRIDGES FOR GERMAN HIGHWAYS.

Neuffer and Schnidtmann—Deutsche Bauzeitung.

IN Germany, as elsewhere, the advantages of reinforced concrete for a great variety of purposes are appealing to engineers. In public works and for many purposes in railroad operation, the use of this material is steadily increasing. While hand mixing is still generally practised, machine mixers are being introduced and are coming more and more into favor. Recent issues of *Deutsche Bauzeitung* have contained descriptions of some notable examples of structures built of concrete, and of these, two bridges, lately completed, are of considerable interest not only on account of the material of their construction, but for their generally substantial appearance and graceful design.

One of these is an arch bridge carrying a highway over a double track railway line near Otting. The railway is in a deep cutting at the point where the road crosses it, and the bridge abutments are placed well up on the banks on either side. Thus, from the track to the under side of the bridge there is a clear height of 41 feet, but the abutment piers being set high up on the slopes, the actual height above the base line of the arch at its center is 20 feet 4 inches. The bridge is of 78 feet 9 inches span, and its total length on the roadway is 161 feet. The roadway is 14 feet 9 inches wide, and is protected at its outer edges by iron hand rails set in concrete posts.

The strengthening of the floor system is effected by means of longitudinal plates between which transverse rods or bars are set, and in the rectangular spaces so formed diagonal rods give the necessary reinforcement to the concrete structure. The members of the arch itself are strengthened by iron rods run through them longitudinally, the outer rods, or those forming the corners of the rectangular section of the arch members, being tied together by diagonal flat ties. The bridge is very rigid, and sufficiently heavy to give a very substantial appearance. The general design is that of an arch with vertical posts resting on it and supporting the roadway above.

The other bridge is much larger and carries a street across a number of railroad tracks in the city of Ulm on the Danube. It is a very wide arch, of 187 feet span,

and carries a roadway and sidewalks protected by parapet walls. The entire width including sidewalks is 33 feet, and the general design resembles that of the ordinary type of structure executed in stone. The design is very simple, the arch being 187 feet wide and 19 feet high above the spring line. The abutments of the bridge are built of stone, faced with Portland cement, so that the whole exterior of the structure is of uniform appearance. The bridge is so large that a good deal of new work had to be done without interfering with railway traffic underneath, and a large amount of timbering had to be used in the construction of the forms while the work was in progress. For mixing the concrete, both hand and machine mixing were employed, and the proportions of cement, sand and crushed stone varied from 1, 2¼, 6¾ to 1, 2½, 5. The total cost is stated to be $39,675, which for a total of 5,938.3 cubic yards, makes the average cost per cubic yard about $6.70.

THE NEW BREAK IN THE COLORADO RIVER.

A DESCRIPTION OF THE OCCURRENCE OF THE BREAK AND THE MEANS EMPLOYED FOR CLOSING IT.

H. T. Cory—Engineering Record.

A REVIEW in the February number of THE ENGINEERING MAGAZINE outlined the history of the diversion of the Colorado River into the Salton Sea and described the attempts that had been made to return it to its original course. Six attempts were made to close the break in the river bank and finally, after a struggle extending over a period of two years, the Colorado was forced back into its original bed and again flowed down to the Gulf of California. Scarcely a month had passed, however, before a sudden flood made a new break in the bank and within a few hours the greater part of the river's flow was again on its way to Salton Sea. The story of the closing of this latest break is told by Mr. H. T. Cory in a recent number of the *Engineering Record*.

"On Nov. 4, 1906, the break in the Colorado River through which all of its flow had been running to the Salton Sea was technically closed, meaning thereby that the rock-fill dam which was thrown across the break was raised at all points above the water surface. Of course quite a little leakage through the dam was taking place and this was checked by unloading gravel and clay over the dam and by pumping a banquette on the upstream side with a suction dredge. On Nov. 15, all of this seepage water was cut off and the dam raised as rapidly as possible with clay and gravel, mixed in about equal portions, that it might be high enough to be safe against the highest water which might be expected in the Colorado River. Work was in progress along the levees connecting the north end of the dam with the reinforced concrete and steel headgate, about 3¼ miles above, which is founded on a rocky point which juts out to within about 1,700 ft. of the west bank of the Colorado River; and from the south end of the dam along the west bank of the Colorado River for a distance of 8 miles.

"A sudden flood due to a rainfall extending over the watersheds of the Gila, Salt and Verde Rivers, reached Yuma late in the afternoon of Dec. 7 and four hours later the water began to rise very rapidly at the Lower Heading, as the location of the break is generally called. The water rose very rapidly, as is usual with such floods, and the height of the water in front of the dam, which had gradually fallen from El. 113 ft. above sea level on Nov. 4 to El. 110 ft. on Dec. 7, reached El. 116.4 by 5 o'clock the following morning. In many places the water began to 'blow up' back of the levees in the vicinity of the dam, and a large force of men which was at work finishing the dam and had been called out in anticipation of trouble, found it necessary to distribute its efforts over about a mile of levee and dam. Three 'blow ups' very close together about 2,500 ft. south of the end of the dam seemed no more dangerous than many others and were apparently checked at 12:30 A. M., Dec. 8. About three o'clock, however, they again broke forth suddenly and more dangerously than before and soon filled the borrow pits which were on the land side and ran off over the ground in a

westerly direction following the slope of the land, which is away from the river bank. Shortly after, the ridges in the borrow pit, which were but little above the original land surface, were overtopped and the water ran for a time in both directions, but the fall of the land being toward the dam into the channel of the old break at the end of the dam, in a very short time the entire flow through the break was in that direction. The soil erodes almost like sugar, and by 5:30 A. M. it was evident that unless the river should fall before the cutting back should reach the old break on the river side of the levees, nothing could prevent a repetition of the original break. The river did fall rapidly, but not sufficiently to prevent the catastrophe, and by noon of the next day the greater portion of the Colorado River was again on its way to Salton Sea.

"The water rapidly cut away a bend which in turn caused a rebound of the water which cut away the back of the levee, and then continued along the levee in the borrow pit to the end of the dam, eroding the downstream slope of both levee and dam. In about eight hours the cutting action on the downstream toe had worn away so much of the levee that it failed at a point near the south end of the dam, and because of the greater depth there the water cut back through this new break more rapidly than elsewhere.

The new break formed a very tortuous channel and the cutting on the outside of the various curves eroded away material with marvelous rapidity. The force of the current coming over the broad shallow reach exactly opposite the dam gathered together in a very narrow and swift current, cutting away the little strip of original soil lying between the break and the levee just south of the dam, and it was soon evident that heroic efforts would be necessary to prevent cutting through the dam itself at its south end. Gravel and rock were dumped at this point as a blanket to protect against such erosion and the efforts were successful.

"In view of the experience in closing the break by means of a rock-fill dam there was little doubt but that closing the new break was a matter of money and equipment very largely, with the difficulty that at this season of the year sudden floods are very apt to occur in the Colorado which would make the task far less certain of a satisfactory result. The real trouble, however, was seen to be not the closing of the break, but the making of a levee system along the Colorado River bank which would be unquestionably safe. The very large expenditure which was seen to be necessary was felt to be too great to be borne by the financial interests which had closed the former break and the matter was brought to the attention of the United States and Mexican Governments.

"On Dec. 20, instructions were received to begin work closing the break, plans for which had been thoroughly matured in the meantime. Material was rushed forward and two lines of trestle started across the new break. These trestles were intended to be 50 feet apart, center to center, and each consisted of four pile bents 15 feet center to center, with two 8-inch by 17-inch stringers as decking. The lower trestle was pushed to the exclusion of the second or upper trestle because it was deemed possible that material could not be gotten on the ground fast enough to drive the two simultaneously.

"The lower trestle was practically completed and rock would have been dumped therefrom on Jan. 1 but for two sources of delay. The first of these was lack of piling which delayed the work about 48 hours and the next was two days and a night of cold drizzling rain which found the camp unfinished to such an extent that the men were thoroughly wet and chilled and so very uncomfortable that they flatly refused to work in the rain on the second day. In consequence another flood from the Gila, the Salt and the Verde River basins came up before any rock could be dumped from this trestle and fifteen bents at its north end were washed away together with about 250 feet of the end of the levee. When this flood went down work was immediately begun repairing this damage, and again a flood came, tearing away several bents in the center and thus changing the channel to the center of the trestle. The water here was about 35 ft. deep, and the current was very swift and struck the trestle at an angle of about 40 degrees. The Colorado River in times of flood carries an immense

amount of drift and this circumstance contributed to make the task of driving the piling in the break of the trestle one of exceedingly great difficulty. Nevertheless the trestle was again finished practically when another flood occurred, coming from the same watersheds and carried away several more bents. It soon passed and these were repaired as soon as possible, 90-foot piling being used, the cut-off being 10 feet above the water surface. Finally on Jan. 27, at 4 o'clock in the afternoon, the first trainload of rock was pushed out upon this patched-up trestle and within 48 hours about 12,000 cubic yards of rock were unloaded therefrom into the bed of the river. On Feb. 2, another rise occurred in the river, but sufficient rock had been gotten into place to hold the first trestle and give a difference in head above and below it of 4.4 feet, so that but twelve piles were washed away from the second trestle, although it had not been possible to entirely finish it and dump any rock from it. The drift piled up against both trestles to an alarming extent, but although it pushed both trestles out of line pretty badly in a couple of places they were not very seriously damaged. Repair work was started on the upper trestle the moment the water in the river started to go down and although the difficulty of driving very long piling in 35 feet of water with a swift current and through a mass of accumulated drift was very great, the second trestle was completed on Feb. 4 and the dumping of rock and gravel from it started at 4 o'clock in the afternoon. On Feb. 4 the discharge in the Colorado River had dropped to about 25,000 second-feet and sufficient material had been dumped from the upper trestle to insure its being made safe against a reasonable flood within the time in which one can reach the Lower Heading from the watersheds which alone can produce such a rise in the river.

"At the present writing there are now working on the reconstruction and extension of the levees and closing the break the following force of men, horses and equipment: 1,220 head of stock, 375 Indians, 400 Mexicans, 500 white men, 4 steam shovels, 1 steamboat, suction dredges, 7 locomotives, not including those hauling rock on main line. In addition there are 200 steel side-dump cars of 45 cubic yards capacity and 450 flat cars in this service exclusively, and the equipment trains and men working in the various outside quarries. Four top and two floating pile drivers had been in use until the completion of the trestle. The total volume of earth to be moved in the levees is 880,000 cubic yards. The total volume of rock which will probably be required to complete the dam proper is something in the vicinity of 100,000 cubic yards, and there will be some 75,000 cubic yards of clay and gravel.

"In the fourteen days' work on closing this last break there were put in place 2,202 carloads of material, aggregating about 52,000 cubic yards of rock, 5,000 cubic yards of clay and about 20,000 cubic yards of gravel. The total length of the trestle is 1,125 feet and the water was allowed to pour over 680 feet of this. The maximum amount of water that ever went over the dam was about 35,000 second feet. The overflow was not uniformly distributed over the entire length of the dam so that in places for several hours there was undoubtedly as much as 100 cubic feet per second per linear foot going over the dam.

"There are three possible, almost probable, sources of failure which may overtake the present work. The first is the possibility that a rock-fill dam cannot be built in a silt formation, which erodes almost as easily as sugar, without any foundation whatever. This is exactly what is being attempted and in the light of experience here it is not believed there will be much trouble from this source. The second is that both trestles are patched-up weak affairs with bents badly spaced and piles out of line and out of plumb. In many cases the alignment was changed and forced downstream in order to utilize to the utmost such portion of the bents which were damaged but not entirely taken away, as was at all safe, in order to begin unloading rock at the earliest possible moment. The third source of possible failure is the possibility of a very great flood coming down the Colorado River and entirely overtopping the trestles or the dam to be, before the dam itself is raised to its final height. The top of the dam will be at El. 124 ft. This is believed to be at least 4 ft. above the highest high-water mark which will ever occur in the Colorado River."

THE HIDDEN COALFIELDS OF THE MIDLANDS.

THE UNDEVELOPED COAL RESOURCES OF ENGLAND WHICH LIE BENEATH THE RED TRIASSIC ROCKS OF THE MIDLAND COUNTIES.

Prof. C. Lapworth—The Mining Journal.

THE gradual exhaustion of the world's coal resources has been viewed with apprehension for a great many years and its threatened menace to industrial greatness has led all manufacturing countries to make extensive and systematic search for new coal areas from which supplies might be drawn after the existing workings are exhausted. Nowhere has the search been prosecuted with greater activity than in England and the successful demonstration of the continuity of the coal deposits now worked, beneath the red Triassic rocks of the Midland counties is one of the triumphs of applied geology. A recent number of the *Mining Journal* contains an abstract of a paper by Prof. Lapworth which describes the occurrence and extent of the hidden coalfields of the Midland counties of England.

"The day was when it was thought that each of our visible coalfields in the Midlands was a single and complete basin in itself, whose coal seams and associated strata had no relation to those of the other visible coalfields of the region. But that primitive opinion has long since been disproved by the advance of geology, and the view now generally accepted among those who have even a passing acquaintance with the science is that all our visible coalfields are merely the exposed coal-bearing portions of what once was a continuous sheet of Carboniferous strata, originally laid down in one and the same grand area of deposition, and afterwards covered up by a similarly continuous sheet of red Triassic rocks. These two rock sheets, the dark Carboniferous below and the red Triassic sheet above, became bent and folded by earth crust movement into broad arches and troughs. From the crests of these arches the Triassic rocks have been swept off by denudation, laying bare the coal measures below. These bared portions now form our visible coalfields.

"But in the broad troughs and depressions between these arches the red rocks of the Triassic sheet still remain intact, while beneath that sheet, at depths which increase, broadly speaking, as we pass outwards from the visible coalfields towards the central parts of the depressions, the coal measure sheet is preserved, and forms an enormous hidden coalfield or coalfields underlying all the country intervening between one visible coalfield and another.

"But while this view is adequate enough as a working generalisation, it is insufficient if we descend to details, for it takes no account of the minor complications which enter into the matter. The coal measures sheet is by no means uniform everywhere, either in character or thickness; for in the northern parts of the Midlands, as in Lancashire and North Staffordshire, the coal measures are a mile in depth, and their middle member is exceedingly rich in workable coal seams, while towards the south the sheet becomes much thinner; finally, all that remains is a mass of sandstones and shales from which coal seams are absent, or, if present, are thin and insignificant.

"The Midland mining community has been by no means slow to follow up the results of geological discovery and speculation, and to extend its mining enterprises well outside the limits of the visible coalfields into the hidden coalfields beyond. The late Mr. Henry Johnson might almost be called the British pioneer in this respect, and his conquest of the hidden coalfield of Sandwell in 1873 was as bold and startling at the time as it was successful in its results. In South Staffordshire alone the total area of hidden coalfields below the red ground already practically proved by workings, shafts, or borings in the Cannock Chase country to the north, the Sandwell-Hampstead-Langley ground to the east, the Baggerdige-Four Ashes country to the west, may be roughly set down as almost equal to one-third of the total extent of the visible coalfield itself.

"During the last fifty years the mining community of Leicestershire and East Warwickshire have doubled the previously known extent of their coal mining coun-

try by opening out the hidden coal measures below the red ground; and the hidden coalfields claimed by mining authorities as already proved below the red ground to the east of the Yorkshire-Nottinghamshire coalfield amounts to more than 500 square miles; indeed, much of this is now being worked from shafts far distant from the visible coalfields.

"But if geologists are right in the conclusions which they draw from the facts won by their researches, the total area of hidden Midland coalfields hitherto entered upon, or even fairly proved by shafts or borings, is but a fraction of that which actually exists. As the output of coal increases, and our visible coalfields begin to show signs of exhaustion, the questions become more pressing year by year: Where do these hidden coalfields occur? and which among them are so situated and so prolific in coal seams that they offer the greatest promise of commercial exploitation and profit?

"The hidden coalfields lie buried under the Triassic cover which overspreads the intermediate basins. Where the elevations slope down very gently into the basins, as in Warwickshire and East Nottinghamshire, the prolongation of the coal seams under the red ground can be followed stage by stage outwards from the visible coalfield itself. This can be done in three ways:—

(1) By working the coal seams foot by foot from the collieries inside the visible coalfield deeper and deeper under the red ground.

(2) By sinking trial borings in the red ground in advance of the workings, and proving the existence of coal measures preparatory to sinking a shaft; or,

(3) By boldly sinking a shaft in the red ground into the hidden coal measures below.

"By these three methods, employed either singly or in combination, large areas of coal-bearing ground have been won, as we have said, from the collective area of the hidden coalfields of the Midlands during the last fifty years, and have been added as proved marginal coalfields to the edges of the visible coalfields of former days.

"The total area of hidden Midland coalfield already proved is about 830 square miles, equal to about one-half the area of the visible coalfields. But this proved ground is a mere fraction of the collective area occupied by the hidden coalfields of the Midlands. While it is as yet impossible, and will be for many years to come, to calculate with any approach to accuracy the exact extent, yet if we make a rough estimate, founded upon the assumption that the profitable coal measures are continued under the red rocks from those points where we find them sinking down under the red ground at the edge of one visible coalfield to the point where we find them emerging again at the edge of another, we may perhaps set down the area of hidden coalfield yet to be tested at some 5,000 to 6,000 square miles.

"But this amount must be largely discounted; for, both from the mining and commercial points of view, there comes eventually a downward limit beyond which it becomes unprofitable to follow these hidden coalfields in their underground extension below the Trias, no matter how promising the geologist may consider them to be as respects the number and quality of the coal seams they may possibly contain.

"In the Florence collieries of North Staffordshire coal is profitably worked to a depth of 3,000 ft., and in the colliery of Pendleton, in Lancashire, to a depth of 3,483 ft. It is not unlikely that the time is fast approaching when such mines will be worked practically to a depth of 4,000 ft., but this may be said to be the downward limit of profitable working as accepted by the mining engineers of the present day. This depth was adopted as the limit by the Commissioners in the Royal Coal Commissions, and we cannot do better than follow their lead in this respect, and set down the limit of possible profitable coal working at a depth of 4,000 ft.

"But this downward limit has a most important bearing upon the matter of the unproved hidden coalfields of the Midlands, and at once removes at least half the area they probably occupy from the category of practical politics. If the Triassic rocks and the underlying non-profitable coal measures of the Midlands retain the same thickness in the cores of the great basins as they possess along their margins,

the productive coal measures in the central parts of most of these basins must be below this limiting depth of 4,000 ft. . . . . .

"Judging from the report of the Coal Commission, only some 800 square miles or thereabouts of the hidden coal-bearing country of the Midlands has hitherto been tested by coal workings or by borings, and all the rest has yet to be proved. Throughout much of this remainder the coal must lie at greater depths than 4,000 ft. But if the conclusions of the geologists who aided in drawing up these reports are well founded, more than 3,000 square miles of hidden coalfield lie as yet untested at less than 4,000 ft. from the surface.

"It cannot reasonably be hoped that very much of this untested ground will be entered upon for many years to come, and in estimating the promise it holds out we must not forget that with every increase of depth the working becomes more difficult and more costly. We cannot safely presume that from all the hidden coalfields yet to be tested the miner can expect to secure an available mineral wealth per square mile proportionate to that of the coalfields already proved.

"It is well to be assured that in all likelihood the collective area of unproved hidden coalfields of the Midlands, in which coal lies within a possible working depth from the surface, is larger than the collective area of the visible and proved coalfields combined. But it will be a great misfortune if this assurance prompts to hasty experiment or rash speculation. The complications are so many that we cannot be too cautious. Our geological researchers must be taught to carry on their work down to the most accurate details. Our mining engineers must be trained to a higher and higher skill to face the growing difficulties."

RAILROAD USES OF WOOD.

A DISCUSSION OF THE IMMENSE CONSUMPTION OF WOOD BY THE RAILROADS AND THE NECESSITY FOR ECONOMY.

Wm. L. Hall--Railway Club of Pittsburgh.

TO no other class of industry has the rapid exhaustion of the forest reserves of the United States presented a problem of greater moment than it has to the railroads. Railroads have always been large consumers of wood but the great activity in railroad building in the last few years has increased the annual consumption to enormous figures. The peculiar requirements of railroad construction have demanded the use of the highest quality of certain limited classes of timber and the increasing scarcity of suitable woods is one of the largest problems with which the railroads have to deal.

Probably the largest item in railroad uses of wood is that of ties, and to show the immense annual consumption of timber to supply this one requirement, the following extracts are taken from the report of the United States Forest Service for 1905.

"The following report upon the cross-ties purchased by the railroads in 1905 is based upon statements from 770 steam railroad companies. Of those which failed to report, only one operates more than 1,000 miles of track, and that one less than 1,300. The average mileage of the remainder is approximately 45. The total mileage unreported is 8,671. Since the total trackage in the United States on January 1, 1905, was, according to Poor's Manual, 293,937 miles, the unreported trackage amounts to but 2.9 per cent. of the total.

"The total number of ties reported is 77,981,227, switch ties being reduced to an equivalent number of cross-ties. Of the total number of ties purchased, 14,459,521, or approximately 18.5 per cent., were for use in the construction of new track, leaving 63,521,706 for renewals. It will be noted that this is less than the total announced in the preliminary statement made by the Forest Service under date of May 17, 1906. This is the result of a correction for duplication made in compiling the preliminary report. Assuming that the unreported 2.9 per cent. of trackage required ties in the same proportion as the reported trackage, the total number of ties purchased by the steam railroads of the United States in 1905 was 81,562,150. Estimating 10,000,000

additional ties for the electric lines, the total number of ties purchased last year in the United States was, in round numbers, 91,500,000.

"The four leading kinds of timber for ties are oak, pine, cedar and chestnut, which combined furnish 83 per cent. of the total number, oak and pine alone furnishing 68 per cent. Next in rank is the red fir of the Pacific Coast and Rocky Mountain region with 4.6 per cent., followed by the cypress of the South with 4.5 per cent. The tamarack, or eastern larch of the New England and Lake States, and the eastern hemlock are the only other species credited with more than 1 per cent. of the total number. Beech, birch, and maple were reported in amounts of less than one-tenth of 1 per cent. each. The miscellaneous classification includes a number of woods, among which the most important are red gum, black locust, elm, hickory, and red cedar. Thus some twenty kinds of timber enter into the production of railroad ties, but of these only seven, at most, are important.

"Until a comparatively short time ago the railroads were usually able to secure an ample supply of ties from lands adjacent to their rights of way. This has been especially true of the vast network of lines which traverse the territory east of the Mississippi River. While this source is by no means exhausted, it has become seriously depleted, and where in former years the purchasing agent could contract for an almost unlimited number of white-oak ties with the assurance that they would be promptly furnished, at the present time it is necessary to contract for small quantities and to anticipate the demand far in advance.

"Where the tie was once the major product, it is now generally a minor product. The Pacific Coast is practically the only region in the United States where ties are produced as a major product of the forest. One of the most important sources of the ties in the East is the farmer's woodlot. During the winter in this region large numbers of ties are hewed and hauled to the railroads."

In a recent paper before the Railway Club of Pittsburgh, Mr. Wm. L. Hall, of the United States Forest Service, discussed the increasing scarcity of timber and laid great stress on the necessity of economy in railroad uses of wood. Mr. Hall remarked the progress that has been made in the building of steel cars but stated that it was important that the railroads pay still more attention to the question of replacing wood by steel in the manufacture of rolling stock. The extensive use of wood for station buildings and connecting approaches and platforms insures economy in first cost but ultimate economy can best be attained by the use of brick, stone or concrete for station buildings, and brick, gravel or cement for walks and platforms. Incidentally, the flooring of wharves and docks, in which large quantities of wood are used, might well be constructed of some more permanent material.

"In bridge construction there is a general movement toward the replacement of wood by masonry or steel, even in small structures. Steel and stone after thorough trial have evidently proved more acceptable materials. In spite of this tendency the Committee on Wooden Bridges and Trestles of the American Railway Engineering and Maintenance of Way Association claims that 'It will be a very long time before wooden trestles cease to be used on most of our railroads.' A large amount of high grade timber is used every year in bridge and trestle construction. This timber should be made as permanent as possible by preservative treatment. Such timbers do not as a rule wear out, they deteriorate by action of the weather and they decay. A treatment which makes them resist weather action and decay will correspondingly increase their service. Railroads in the West and South are treating bridge and trestle timbers quite extensively.

"The wooden pile is an article which, so far as I am informed, has not been successfully replaced. Regardless of what may be done to replace wood in other places it seems that the wooden pile must remain in favor indefinitely. A vast quantity of timber is annually cut for piling, and the worst of it is that these fine poles—the best product of the forest—have often vanished within a few months before the onslaught of marine borers when placed in brackish water, or they have decayed within a few years in situations favorable to the growth of injurious fungi. With rising prices we

are passing out of conditions which have made such methods practicable. We must use wooden piles but we cannot afford to place them at great expense and then allow them to be immediately consumed by insects or fungi. They must be protected. Experience has taught that the best protection against both insects and decay is a thorough impregnation of creosote. A good quality of creosote stays in the wood indefinitely, and so long as it is there in sufficient quantity neither borers nor fungus will attack it. In economizing in the use of wooden piles, then, we must look, not to substitution, but to the continued use of wood with the best possible protection.

"Another class of railroad timbers which must be considered is made up of telegraph poles and fence posts. These must be had in considerable quantities and the only satisfactory material from which to make them is wood. As in the case of the wooden pile the problem is one, not of substitution, but of protection. Unlike the pile, the telegraph pole and the fence post require protection only for a few feet at the ground end. Decay takes place in a damaging manner only over that part from a few inches above to a few inches below the surface. That is the only part which it is vitally necessary to treat. This simplifies the problem of treatment in one way but complicates it in another. It makes it possible to use less of the preservative, thereby reducing expense, but it makes necessary equipment not found in the ordinary treating plant. Without stopping to discuss the detail of operations, however, which it is not the purpose of this paper to present, let me say that the Forest Service has made careful and extensive experiments in the butt treatment of both poles and posts and the results warrant belief that it is entirely practicable. With relatively small expense a penetration of one-half inch to two inches can be secured. One telephone company is already taking up this form of treatment and probably within a few years it will be in common use."

With regard to the tie situation, Mr. Hall says:

"In your September meeting one of the members of this Club, in discussing the merits of steel and wooden ties, said: 'While I believe that the best tie is a first class white oak tie, 7 inches thick, 9 inches face, 8 feet 6 inches long treated with some preservative, yet we all know that such ties are very scarce and the railroads are about facing the problem of purchasing ties of other material than wood. We need not stop at this time to state just why an oak tie is better than a steel tie. The reasons are many. The superiority of white oak ties is generally recognized by railway engineers in charge of maintenance of way, and the advocates of steel ties do not deny this superiority. The purchase of steel ties is being advocated because timber cannot be procured in sufficient quantities to supply the demand for cross ties. It is no longer possible in the United States to purchase 80,000,000 first class cross ties per year. The supply of durable timber is inadequate.'

"If the first class white oak tie has such manifest advantages over the steel tie I am not certain that we must decide for the latter because white oak is growing scarce. It should be decided first whether other woods can be so protected and used as to obtain the serviceableness of white oak.

"Railroad practice is working in this direction. Tie plates have been introduced with marked success on many roads for the protection of soft-wood ties. A very great advance is being made just now toward the preservative treatment of ties. Ten per cent. of the ties used last year were treated. All efficacious treatment helps because it largely eliminates decay, which has been the greatest factor in weakening ties. There is ground for believing that by certain forms of creosote treatment the tie can be both hardened and strengthened. The form of spike can be bettered so that the union between the tie and rail will be firmer, and the tie thereby protected. The better ballasting of the track will also protect the tie. These means of protection will bring the tie of other woods approximately to the white oak standard, and all these means of protection can be accomplished by most railroads more easily than they can change to the steel tie.

"If we change from the wood to the steel tie we should do so only because all around steel is the best material for the purpose. If steel or concrete or any other material

actually proves better than wood then that material ought to be adopted. If wood remains the most acceptable tie material we ought not to discard it on the ground of present scarcity.

"In my opinion, the present situation is to be met, not by hastily abandoning wood in favor of some other material of unproved acceptability which may also in time become scarce. The situation is to be met first, by the use of other materials where we know they are better; second, by the best possible protection to the wood where it proves the best material; third, by protection and care of the forest in order that nature, by its own process of growth, may, through all time to come, supply the wood needed by the industries."

THE RESISTANCE OF MATERIALS.

A DISCUSSION OF THE IMPORTANCE OF CAREFUL STUDY OF THE INFLUENCE OF THE TIME-FACTOR IN THE RESISTANCE OF MATERIALS.

Engineering.

THE doctrine of the essential simplicity of nature has been the basis on which most of the pioneer work in every branch of science has been attempted and it is questionable whether a start would ever have been made in many a line of investigation had not its originators been imbued with a strong sense of the substantial truth of this dogma. In actual experience, however, the principle has been disproved in every branch of science and it is by no means improbable every one of the great generalisations which we term "natural laws" will ultimately be proved to be nothing more than a first approximation to the actual state of affairs, as improved methods of experiment render possible more accurate observation. An editorial in a recent number of *Engineering* points out the necessity of a more thorough investigation of the principles on which the design of all classes of structures is based, with especial reference to the influence of the time-factor in the resistance of materials.

"With respect to the laws governing the strength of materials, sad experience has shown that the simple principles by which the great engineers of the past proportioned their structures are by no means universally applicable. They proceeded on the straightforward and common-sense plan of determining, or assuming, the ultimate strength of their material, and divided this by a factor of safety, in order to fix the proper working load which it would be prudent to permit.

"It was soon found, however, that a factor of safety which experience showed sufficient in one case might be totally inapplicable in another, the variations depending not only on the method of loading, but also with the nature of the material used. Short girder bridges have been commonly built with a nominal factor of safety of 5, and a similar factor is generally used in boiler work. In small arms, however, in which the stresses are very similar in character to those obtaining in a boiler, the factor of safety is less than 2, as pointed out by Mr. Stromeyer in the interesting address which he delivered last November to the Manchester Association of Students of the Institution of Civil Engineers. Here, moreover, the load is an impulsive one, whereas in a boiler the load is remarkably steady, the range of variation being extremely small, and its rate of alteration very slow, both of which are conditions which are generally held to permit of the adoption of a low factor of safety. On the other hand, of course, provision has to be made for the risk of corrosion, which is negligible in the case of a firearm. Mr. Stromeyer rather criticises the use of the term 'factor of safety' at all, and would prefer that a definite working stress should be specified instead, varying with the nature of the material and the condition of loading. This is doubtless the most rational method of procedure, and may be often advantageously adopted, when a reasonably accurate analysis of the stresses obtaining in the structure under consideration is possible. Even then, however, the alternative method has some advantages, as it gives a rather better idea of the extent to which the load may, as an emergency,

be temporarily increased. Thus, with a factor of safety of five, it is permissible to test boilers up to twice their designed working pressure; but, obviously, if the factor of safety of a small-bore rifle is under two, a proof pressure of double the working pressure is inadmissible. . . . . .

"The term 'elastic limit' introduces another point in which the simple ideas which guided the early engineers have proved inadequate for the description of the actual facts of experience. It was first found that the elastic limit, as usually defined, was a variable quantity, depending on the previous history of the metal, and that by suitable treatment the limit could, in the case of steel, be raised almost up to the breaking-point. Later on, Bauschinger introduced the idea of an elastic range, and showed that steel had two elastic limits—one for tension and one for compression; and that raising the elastic limit in tension lowered that in compression to a nearly equal degree. He further concluded that to ensure safety in a structure subject to varying stress, the range of stress must not be greater than the elastic range of the material. Here, again, engineers were presented with a simple and readily intelligible explanation of their experience with materials subject to alternating stresses, best exemplified, perhaps, by Wöhler's classical experiments. No sooner, however, had this idea—which is not only plausible in itself, but is undoubtedly to a very large extent, well based—become general property, than matters were again complicated by Professor Osborne Reynolds, who showed that the endurance of a bar under alternating stresses was not merely a function of the range of stress, but depended also on the rapidity of the alternations, so that the hard steels, which in general show much greater endurance than the milder qualities, break down at much the same stresses, if the rate of variation is sufficiently high. This result is a most important one, though undoubtedly in a vast number of practical applications the harder steels do show to great advantage in the matter of endurance. . . . . .

"A matter on which further light is badly needed is the influence of this time factor on the endurance of materials. There is some reason for believing that relatively high stresses, if transient, can be carried without injury to the material; yet this view seems discordant with the experiments of Professor Osborne Reynolds, and also with the experience of high-speed-engine builders. It is known that if a stress is applied to a bar within the so-called elastic limit, the bar does not immediately take its full amount of stretch, but a certain creep continues for some time after the application of the load. Similarly, on the removal of the load, the bar does not recover its original length immediately, there being again a certain amount of creep, which dies away relatively slowly. Some elasticians have assumed, as the basis of their investigations into the resistance of structures, that the safety of the structure was inversely proportional to the maximum strain induced by the stresses; and were this correct, it would seem that bars should be stronger under very rapidly alternating stresses than when the rate of change of stress is slow, since the phenomenon of creep indicates that the molecular displacement should be less in the former case. This view, however, seems negatived by experience; but, on the other hand, no one now accepts Rankine's simple theory that, in the case of compound stresses, safety varies inversely as the maximum tensile or compressive stress in the material. A good deal of light has been thrown on this latter point by the researches of Mr. Guest, which have confirmed the views of many recent elasticians, that the safety varies inversely as the maximum shear.

"Whilst Time, which is proverbially a healer, does appear to have considerable curative abilities in the case of the mechanical overstrain of materials, its influence on other forms of injury appears less beneficial. Mr. Stromeyer, in the paper to which we have already referred, relates that a specimen of steel, on which work had been done at blue heat twenty years ago, proved as brittle when recently tested as similar specimens broken at the time of treatment. Moreover, he has also recently shown grounds for believing that certain kinds of steel have a natural tendency to become brittle with age, even when moderately loaded under steady stresses. Here, again, there is need for an extended investigation into the influence of the time-factor."

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Cantilever.

The Blackwell's Island Bridge. Illustrated detailed description of a noteworthy example of eyebar cantilever construction now being erected by the Pennsylvania Steel Co. at New York. 2500 w. Ir Age—March 7, 1907. No. 82788.

Erection of the Cantilever Spans of the Blackwell's Island Bridge. Illustrated description of the erection of this bridge which crosses the two channels of the East River, and over Blackwell's Island at New York. 2200 w. Eng Rec—March 2, 1907. No. 82728.

Cofferdams.

Steel Sheet Piling for Bridge Pier Cofferdams. Illustrated description of the construction of an electric railway bridge crossing the Illinois River at Peoria. 1800 w. Eng Rec—March 2, 1907. No. 82714.

Concrete.

Three-Hinged-Arch Bridges of Concrete (Ponts en Béton à trois Rotules).

We supply copies of these articles. See page 316.

Descriptions of two bridges over the Iller River at Lautrach and Kempten, Bavaria, methods of construction, etc. Ill. 2200 w. Génie Civil—Feb. 16, 1907. No. 82984 D.

Connecticut River.

The New Connecticut River Bridge of the New York, New Haven & Hartford Railroad. Illustrated description of the bridge between Lyme and Saybrook, Conn., which will eventually be a four-track structure, though the superstructure for only the two south tracks will for the present be in service. 1200 w. Ry Age—March 22, 1907. No. 83254.

Guatemala.

The Rio Fiscal Bridge on the Guatemala Railway. Diagrams and description of a bridge 350 ft. long between abutments, which has a three-hinge spandrel-braced arch span of 209 ft. flanked by two plate girder approach spans of about 30 ft. each at both ends. 1200 w. Eng Rec—March 23, 1907. No. 83218.

Hudson River.

The New Sandy Hill-Fenimore Concrete-Steel Bridge Across the Hudson River, N. Y. Illustrated description of a structure including 15 arched spans, each 60-ft. in the clear. The exterior walls were of hollow concrete blocks, and the hollow places poured full of cement, making the structure monolithic. 1500 w. Cement—March, 1907. No. 83166 C.

India.

Khushalgarh Bridge. Illustrated detailed description of a steel cantilever bridge now under construction over the River Indus. Plates. 1500 w. Engng—Feb. 22, 1907. No. 82834 A.

Long Spans.

Noteworthy Early Examples of Long-Span Bridge Erection. Frank W. Skinner. An illustrated review of different methods employed on famous bridges. 7000 w. Eng Rec—March 2, 1907. No. 82709.

Mississippi.

Proposed New Bridges Over the Mississippi River at St. Louis, Mo. Map, showing present and proposed bridges, giving some particulars in regard to them. 1500 w. Eng News—March 21, 1907. No. 83206.

Missouri River.

Missouri River Bridge of the Chicago, Milwaukee & St. Paul at Mobridge, S. D. Map showing location, with illustrated detailed description. 3000 w. Ry Age—March 22, 1907. No. 83251.

Movable.

Movable Bridges. C. C. Schneider. A review of the mechanical features of movable bridges, with a set of specifications covering their operating machinery, submitted for discussion and criticism. 13600 w. Pro Am Soc of Civ Engrs—Feb., 1907. No. 83038 E.

Natal.

The Connaught Bridge, Natal. Edward John Stead. A description of this bridge of twelve spans and its erection. 3 plates. 7000 w. Soc of Engrs—March 4, 1907. No. 83172 N.

Nile.

The New Nile Bridges at Cairo. An account of the progress of the work on the three bridges under construction, illustrating the Rodah bridge—535 metres, or 1,755 ft., in length, and having a swing span. 1300 w. Engr, Lond—March 1, 1907. No. 83002 A.

Quebec.

The Erection of the South Anchor Arm of the Quebec Bridge. The equipment of the traveler is illustrated and described and methods of erection explained. 2200 w. Eng Rec—March 2, 1907. No. 82731.

Reconstruction.

The Reconstruction of the Parkersburg Bridge on the Baltimore & Ohio R. R. The amount of traffic and increased weight of locomotives made it necessary to replace the channel spans of this bridge by stronger ones. Illustrates and describes the method of carrying out the work without interruption of traffic and obstruction of the river. 4500 w. Eng Rec—March 9, 1907. No. 82860.

Reinforced Concrete.

Reinforced Concrete Bridge Over the Cumberland River. Ward Baldwin. Illustrates and describes the method of construction. 500 w. R R Gaz—March 22, 1907. No. 83211.

Building the Washington Street Bridge in Dayton, Ohio. A reinforced concrete structure of the Melan arch type, with seven spans, is illustrated and its construction described. 2500 w. Eng Rec—March 2, 1907. No. 82715.

Reinforced Concrete Arch Bridges (Bogenbrücke in Eisenbeton). Wilhelm Schnidtmann. Short description of a German railway bridge. Illus. 800 w. Deutsche Bauzeitung—Feb. 6, 1907. No. 82907 D.

The Wallstrasse Bridge in Ulm (Die Wallstrassenbrücke in Ulm a. D.). Herr Neuffer. Description of a reinforced concrete arch bridge of 215 ft. span. Illus. 2900 w Serial. 3 parts. Deutsche Bauzeitung—Jan. 9 and 23, and Feb. 6, 1907. No. 82906 each D.

Replacement.

Erection of the Lehighton Bridge of the Central R. R. of New Jersey. Illustrates and describes the erection of a double-track, through, riveted truss, skew span, to replace an old bridge, with as little interference as possible with traffic. 2500 w. Eng Rec—March 2, 1907. No. 82724.

We supply copies of these articles. See page 316.

Susquehanna.

A Long Plate-Girder Bridge and Grade and Alinement Changes on the Lehigh Valley R. R., at Towanda, Pa. Philip H. De Witt. Illustrated description of important improvements in progress. 1200 w. Eng News—March 14, 1907. No. 83130.

The New Lehigh Valley Bridge Over the Susquehanna River, Near Towanda, Pa. Illustrates and describes a 14-span bridge built in connection with railroad improvements at this point. 1200 w. Eng Rec—March 2, 1907. No. 82737.

Swing Bridges.

Design of Swing Bridges from a Maintenance Standpoint. C. H. Cartlidge and discussion. More of a symposium than the regular form of a paper and discussion, considering the subject from the operating and maintenance standpoint. Illus. 24000 w. Jour W Soc of Engrs—Feb., 1907. No. 83184 D.

Timber.

The Long Bridge Across the Potomac at Washington, D. C. Photographs and brief description of one of the oldest timber Howe truss bridges in America, built in 1809 first, and rebuilt in 1834, and repaired more recently. It is now being removed. 700 w. Eng News—March 14, 1907. No. 83138.

Viaducts.

Erection of El Rodes Viaduct, Guatemala Railway. Illustrates and describes the methods of erection. 1600 w. Eng Rec—March 2, 1907. No. 82723.

The Reinforced Concrete Viaduct of the Richmond & Chesapeake Bay Railway at Richmond. Illustrated detailed description of this structure and its construction, with information relating to the work. 2500 w. Eng Rec—March 2, 1907. No. 82708.

Reconstruction of the Amsterdam Viaduct (De vernieuwing van de Westelyke Viaduct te Amsterdam). C. Leemans. Illus. 7500 w. Serial. 1st part. De Ingenieur—Feb. 2, 1907. No. 82957 D.

CONSTRUCTION.

Assuan Dam.

The Assuan Dam Protective Works. Details from the last report of A. L. Webb relating to the preventing of further erosion from the pressure of water discharged through the sluices of the dam. 2500 w. Builder—March 9, 1907. No. 83094 A.

Borings.

Cost of Earth Auger Borings on the New York State Barge Canal. Emile Low. Gives data relative to borings made with fence post hole diggers, or "earth augers," with which some 450 test holes were dug on Section 5. 400 w. Eng News—March 21, 1907. No. 83202.

Methods and Cost of Making Wash Drill Borings on the Great Lakes and Atlantic Ship Canal Survey. A summary of facts given regarding the methods and costs of making wash borings in surveying the possible routes for the proposed ship canal connecting the Great Lakes with Atlantic tide waters. 1700 w. Engng-Con—March 27, 1907. No. 83275.

Methods and Cost of Making Diamond Drill Borings, Deep Waterways Survey, Great Lakes to Atlantic Tide Waters. Gives a record of diamond drill borings of shallow depths, the methods and cost. 1500 w. Engng-Con—March 13, 1907. No. 82868.

Boulevard.

Progress of Construction on the Riverside Drive, New York. An illustrated article describing recent work on this great boulevard. 2000 w. Eng Rec—March 2, 1907. No. 82711.

Building.

The Construction of the Trinity and United States Realty Buildings, New York. Illustrated detailed description of somewhat unusual work carried out in this congested district of New York City. 3800 w. Eng Rec—March 2, 1907. No. 82736.

Checking.

The Checking of Structural Steel Deliveries for Mill Buildings. F. L. Smith. Outlines the methods tried of checking the delivery of material and the inspection necessary to correct defects or inaccuracies before erection. 1600 w. Eng Rec—March 2, 1907. No. 82719.

Concrete.

A Concrete House in the Jamaica Earthquake. Illustrates and describes the concrete building which successfully withstood the shock. 2500 w. Cement Age—March, 1907. No. 83162.

Concrete Blocks.

Concrete Block Construction for Residences, Methods and Costs. Noyes F. Palmer. Discusses concrete block construction in general and also a particular residence at Quogue, Long Island. 2000 w. Engng-Con—March 6, 1907. No. 82783.

Country Houses.

The Engineering of a Country House. Illustrated detailed description of work carried out on a beautiful estate in Surrey, about 24 miles from London, which aimed to equip the estate with all modern applications of sanitary science and electric lighting. 4500 w. Engr, Lond—March 8, 1907. Serial. 1st part. No. 83119 A.

We supply copies of these articles. See page 316.

Culverts.

Concrete Pipe Culverts. O. P. Chamberlain, with discussion. Considers the possibilities of this type of culverts. Ills. 7500 w. Jour W Soc Engrs—Feb., 1907. No. 83185 D.

Excavators.

Scraper Excavators. Illustrates and describes types of excavators being used extensively on various kinds of work. 2000 w. Eng News—March 21, 1907. No. 83201.

Foundations.

Concrete Pneumatic Caisson Foundations. Edwin F. Kellogg. A detailed description of the building of foundations for the 41-story Singer Building in New York City. Ills. 2000 w. Cement Age—March, 1907. No. 83161.

The Pneumatic Foundations of the City Investing Building, New York. Describes the property adjacent to this thirty-two story building, and the underpinning methods employed, giving an illustrated description of the difficult foundation work. 4000 w. Eng Rec—March 2, 1907. No. 82722.

Foundation Problems in New York City. C. M. Ripley. An illustrated study of the laying of the foundations for the new building of the Trust Company of America in the Wall St. district, showing the increasing engineering difficulties that must be met. 1800 w. Munic Engng—March, 1907. No. 82694 C.

Difficult Foundations of the Hoffman House Extension, New York. Describes the conditions of adjacent buildings and the bracing and underpinning, the use of steel sheet piles, and the difficult excavation. 3000 w. Eng Rec—March 2, 1907. No. 82733.

Office Building.

A Twentieth Century Campanile. Illustrations showing comparison of the Metropolitan Life Insurance Co.'s tower, 658 ft. above the sidewalk, with other high structures, with remarks on features of construction. 1300 w. Sci Am—March 30, 1907. No. 83298.

Rapid Work.

Another Reinforced Concrete Speed Record. George J. Seymour. Illustrated account of the erection of the new works of the Anderson Carriage Co., of Detroit. 4000 w. Cement Age—March, 1907. No. 83165.

Reinforced Concrete.

French Government Rules for the Design and Construction of Reinforced Concrete. Abstract of instructions prepared for the French Ministry of Public Works, with comments. 2000 w. Eng News—March 21, 1907. No. 83199.

Hints on the Design and Execution of Reinforced Concrete Works. E. P. Goodrich. Suggestive notes from the experience and observation of the writer. 10,000 w. Eng Rec—March 2, 1907. No. 82726.

Reinforced Concrete Construction: Its Proper Application in Earthquake Countries. Charles Derleth, Jr. A discussion of this material, its use, applications, designs, stresses, etc. 4800 w. Jour Assn of Engng Socs—Feb., 1907. No. 83040 C.

Reinforced Concrete Design and Construction. W. P. Day. Discusses some of the factors essential to an economical structure of this material, and gives the safe unit stresses as allowed in a recent report to govern the use of this material in France. Ills. 1800 w. Cal Jour of Tech—March, 1907. No. 83188.

Reinforced-Concrete Construction. William O. Ludlow. From a lecture on Architectural Engineering delivered at Stevens Inst. Tech. Considers, as an example, the planning and construction of an 8-story loft building. 3000 w. Stevens Ind—Jan., 1907. No. 83308 D.

Recent Papers on Reinforced Concrete Construction in Europe (Neuere Vorschriften, betreffend die Bauweise in Betoneisen). Abstract of papers recently read before German Engineering Societies. Diagrams, formulæ. Serial. 1st part. 4400 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Jan. 5, 1907. No. 82930 D.

The Mechanics of Reinforced Concrete. C. B. Wing. Considers the development of formulæ, the principles and methods to be used in application of formulæ, giving comparison of results obtained by formulæ with results of tests. 4800 w. Jour Assn of Engng Socs—Feb., 1907. No. 83039 C.

The Herbivora Building in the Cincinnati Zoölogical Garden. Illustrated description of a recently completed reinforced concrete building having special features of design. 2000 w. Eng Rec—March 2, 1907. No. 82716.

A Chicago Warehouse of Reinforced Concrete Construction. Brief illustrated description of an interesting example of the application of this material to warehouse construction. 1200 w. Eng News—March 28, 1907. No. 83321.

Retaining Walls.

Armored Concrete Retaining Walls. Discusses a design brought forward by M. F. Chaudy, in a communication to the Soc. of Civ. Engrs. of France, which proposes to employ a combination of armored concrete and ordinary masonry, and to introduce horizontal platforms at the back of the walls which will support the weight of earth. Diagrams. 1500 w. Engr, Lond—Feb. 22, 1907. No. 82840 A.

We supply copies of these articles. See page 316.

Roads.

The Benguet Road, Luzon, P. I. Brief account of difficult road construction in the Philippine Islands. 1400 w. Eng Rec —March 23, 1907. No. 83220.

Stresses.

The Factor of Safety. J. P. E. C. Stromeyer. Presidential address delivered to Inst. of Civ. Engrs., Manchester Assn. of Students. An interesting discussion of the origin of the expression "factor of safety," and its application to engineering. 4800 w. Engr, Lond—March 8, 1907. Serial. 1st part. No. 83124 A.

Tile.

Cohesive Fireproof Tile Construction. Describes recent work where improved terra-cotta tiles are used. The new Custom House in New York City, and new Madison Square Presbyterian church, furnish examples of domes constructed of this material, and other work is described. 1700 w. Sci Am—March 23, 1907. No. 83147.

Tunnels.

Grade Correction in the Battery Tunnel. The correction of irregularities in the alignment of this tunnel between New York and Brooklyn, the difficult and delicate work of raising the roof and depressing the invert under a heavy pressure, is illustrated and described. 2000 w. Eng Rec—March 2, 1907. No. 82729.

The New York Subaqueous Tunnels. Charles Prelini. The present number outlines the tunnel work in progress round New York City, and later articles will describe four of the more important tunnels. Ills. 2000 w. Engng—March 8, 1907. Serial. 1st part. No. 83113 A.

Progress of work in Lowering the Tunnels Under the Chicago River. William Artingstall. An illustrated account of progress and methods in the lowering of the three street railway tunnels under the river to give the required depth of 26 ft. in the Chicago River. 2000 w. Eng News —March 7, 1907. No. 82796.

The Detroit River Tunnel of the New York Central Lines. Illustrated description of the construction and design of this subaqueous tunnel consisting of riveted steel tubes built on shore, floated and sunk and surrounded by a monolithic mass of concrete. The interiors of the tubes are lined also with concrete 20 in. thick. 3000 w. Eng Rec—March 2, 1907. No. 82720.

Underpinning.

Underpinning a Three-Track Subway. Illustrates and describes methods used for unusually heavy trench bracing. 1500 w. Eng Rec—March 2, 1907. No. 82735.

Methods Used in Underpinning the Singer Building, New York. Describes the conditions to be met and the arrangement for temporary support of a wall on needle-beams until the caisson foundations were completed. Ills. 2000 w. Eng Rec—March 2, 1907. No. 82725.

Shoring a Fifteen-Story Office Building in Chicago. Briefly describes the Champlain store and office building, and the shoring required during the construction of an adjacent building. Ills. 3700 w. Eng Rec—March 2, 1907. No. 82710.

MATERIALS OF CONSTRUCTION.

Beams.

Fundamental Ideas on the Strength of Beams. John D. Adams. A graphical presentation of the stresses in a bending beam, with explanation. 1500 w. Mach, N Y—March, 1907. Serial. 1st part. No. 82766 C.

The Elastic Limit of a Rod under Tension and Bending Strain (Der elastich eingespannte, auf Zug und Biegung beanspruchte Stab). Ivan Arnsvlevic. Mathematical treatment. 2100 w. Oest Wochenschrift f d Offentlichen Baudienst—Jan. 26, 1907. No. 82935 D.

A New Method of Calculation of Beams. A. P. Jacob. Describes a method for computing the section of a reinforced concrete beam. 500 w. Cement Age—March, 1907. No. 83163.

Strains in Beams of Rectangular Section with Curved Axes (Die Beanspruchung stabförmiger Träger mit gekrümmter Mittellinie). C. Pfleiderer. Mathematical treatment. Diagrams. 1400 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 9, 1907. No. 82923 D.

Fire and Load Test of a Reinforced Concrete Beam. H. B. Macfarland. Gives details of an experimental fire and load test. Ills. 1000 w. Eng News—March 21, 1907. No. 83205.

Building Stone.

The Characteristics of Good Building Stones. R. D. George. Discusses their essential qualities, such as strength, durability, workability and color, and the facts determining these qualities. 6000 w. Ores & Metals—March 20, 1907. No. 83231.

Cement.

Comparative Strength Tests of Cement Mortar (Vergleichende Festigkeitsversuche an Körpern aus Zementmörtel). M. Grübler. Description of apparatus and results obtained. Illus. 5700 w. Zeitschrift des Vereines Deutscher Ingenieure —Feb. 2, 1907. No. 82920 D.

Concrete.

A Normal Concrete. Louis H. Gibson. Discusses the question of the formation of the aggregate in the manufacture of concrete. 2500 w. Munic Engng—March, 1907. No. 82693 C.

Cost of Fence Posts and Other Concrete Work of Dellwood Park. Describes

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concrete work at an amusement resort in Illinois, giving a report of costs. 1400 w. Eng Rec—March 23, 1907. No. 83213.

The Laws of Proportioning Concrete. William B. Fuller and Sanford E. Thompson. A detailed account of experimental tests made, with results and conclusions, giving many tables, and much valuable information. Ills. 17500 w. Pro Am Soc of Civ Engrs—March, 1907. No. 83328 E.

Corrosion.

Electrolytic Corrosion of Iron and Steel in Concrete. A. A. Knudson. Gives results of laboratory experiments made to obtain data as to the amount of current and time necessary to cause corrosion upon metals incased in concrete or hydraulic cements, and to test their value as electrolytes. Ills. 3000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83044 D.

The Liability of Reinforced Concrete to Electrolytic Damage. Editorial on the paper of A. A. Knudson, before the Am. Inst. of Elec. Engrs. discussing the electrolytic damage that may affect metal imbedded in concrete. 1300 w. Eng News—March 21, 1907. No. 83203.

Dams.

Experiments on Material for Cold Springs Dam, Umatilla Irrigation Project, Oregon. D. C. Henny and E. G. Hopson. Outlines this project and the earth dam 3,200 ft. long, with a maximum height of 82 ft., explaining the methods of sampling and testing the materials available for its construction. Diagrams. 3500 w. Eng News—March 7, 1907. No. 82795.

Hooped Concrete.

Hooped Concrete and Its Applications (Le Béton fretté et ses Applications). A. Considère. Discusses methods of circular reinforcement and compares this method with ordinary longitudinal reinforcement for columns, etc., giving results of tests of strength, elasticity, etc. Ills. Serial. 1st part. 2000 w. Génie Civil—Feb. 9, 1907. No. 82985 D.

Mortar.

Action of Sea Water on Mortar. Eug. Mayer. A report of trials made at La Rochelle and presented at the Brussels Congress of the International Assn. for Testing Materials. 1500 w. Cement Age—March, 1907. No. 83164.

Reinforced Concrete.

Reinforced Concrete. H. N. Allott. Read before the Manchester Assn. of Engrs. Considers the preparation and use of this material, the working stresses, etc. 2200 w. Prac Engr—March 1, 1907. Serial. 1st part. No. 82886 A.

Tests of Bond Between Concrete and Steel. T. L. Condron. Considers the factors upon which the adhesion depends, and gives results of a series of bond tests made to investigate the relative strength of bond developed by different forms of bars in the same kind of concrete and under otherwise identical conditions. Ills. 4000 w. Jour W Soc of Engrs—Feb., 1907. No. 83186 D.

Accurate Calculation of Compound Construction (Angenäherte und genaue Berechnung von Verbundkonstruktionen). P. Göldel. Mathematical treatment of strength of reinforced concrete. Diagrams. 2500 w. Oest Wochenschrift f d Offentlichen Baudienst—Feb. 2, 1907. No. 82932 D.

Wood.

The Necessity of Economy in Railroad Uses of Wood. William L. Hall. Explains the present situation, showing the railroads to be large users of timber, and the shortage of the product. Suggests that other materials be substituted wherever they are known to be better, protecting the wood where used, and the care of forests. Discussion. Also a copy U. S. Dept. of Agriculture Circular 43, in regard to cross-ties. 9500 w. Pro Ry Club of Pittsburgh—Dec. 28, 1906. No. 83033 C.

MEASUREMENT.

Chaining.

The Method and Apparatus for Chaining Used by the Topographical Bureau, Borough of Queens. George J. Falkinburg. Illustrated description of accurate chaining apparatus. 1500 w. Eng News—March 14, 1907. No. 83137.

Metering Plant.

Venturi Meters at Rio de Janeiro. Illustrates and describes an elaborate plant comprising not less than twenty separate Venturi meters, which will measure the waters received from as many sources of supply, the flow being recorded not only locally but also transmitted to a central station. 2000 w. Engng—Feb. 22, 1907. No. 82835 A.

Roads.

The Viagraph. Illustrations, with brief description of a road-testing machine. It automatically traces every inequality over which it is drawn. 500 w. Sci Am Sup—March 2, 1907. No. 82648.

Survey.

The Ohio River Survey. Roger Baldwin Colton. Brief account of the work below Louisville, Ky., during the summers of 1905-6. Ills. 1800 w. Yale Sci M—March, 1907. No. 83159 C.

Surveying.

Some Tests in Sighting at Leveling Rods and Stadia Rods. John C. Tracy. Presented at meeting of the Connecticut

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Soc. of Engrs. Gives the results of four tests made to determine the probable errors in setting a target on a leveling rod; reading a rod directly without using a target; measuring horizontal distances with the stadia; measuring differences in elevation by the stadia and vertical-angle method. 1800 w. Eng News—March 21, 1907. No. 83200.

Transit.

The Verschoyle Pocket Transit. W. Denham Verschoyle. Illustrated description. 800 w. Eng & Min Jour—March 2, 1907. No. 82690.

MUNICIPAL.

Asphalt.

Sheet Asphalt Specifications. Gives the latest specifications for Washington, D. C. 2000 w. Munic Jour & Engr—March 6, 1907. No. 82785 C.

Pavements.

Experience with Various Pavements on Streets with Heavy Grades. C. G. Anderson. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Cross-sections and descriptions of styles of paving employed on streets with heavy grades, at Moline, Ill. 3500 w. Eng News—March 14, 1907. No. 83134.

Hassam Pavement. W. A. Luey. Describes this new concrete pavement, named for the inventor, and the manner of laying. 1200 w. Cal Jour of Tech—March, 1907. No. 83189.

Sheet Asphalt Pavements. H. C. Innes. Information relating to the selecting of materials, laying, etc. 3000 w. Munic Engng—March, 1907. No. 82695 C.

The Method, Cost and Results of Tarring Heavily-Traveled Macadam Streets in Chicago. Explains the greater wear on streets due to the extensive use of automobiles, and gives particulars relating to tarring, the results being considered sufficiently satisfactory to justify a continuance of the work. A statement of cost is given. 2200 w. Eng Rec—March 16, 1907. No. 83071.

The Cost of Materials and Wages of Labor for Paving Work in Representative American Cities. Tabulated statements of costs for various kinds of pavement, with remarks. 1000 w. Engng-Con—March, 1907. No. 83276.

Oiled Roads in California. Notes from the biennial report of N. E. Ellery, State highway commissioner, giving extracts from the specifications for the construction of oiled graveled streets. 2000 w. Eng Rec—March 23, 1907. No. 83215.

Pipe Subways.

Pipe Subways in British Cities and in Paris. Illustrates and describes subways in a number of foreign cities, giving information regarding cost and other matters of interest. 7500 w. Eng News—March 14, 1907. No. 83132.

Road Traffic.

The Illinois Road Traffic Census. A. N. Johnson. Abstract of a paper read before the Ill. Soc. of Engrs. & Survs. Gives results of a systematic effort to obtain information in regard to traffic conditions and their effect on the roads, etc. 1800 w. Eng Rec—March 16, 1907. No. 83070.

Septic Tanks.

Decision in the Cameron Septic Tank Suit Against Saratoga Springs, N. Y. Gives the decision of Judge Ray, in this suit in equity to restrain alleged infringement and for an accounting. Reviews the claims of the Cameron patent and of many phases of earlier sewage treatment. 12000 w. Eng News—March 28, 1907. No. 83322.

Sewage.

Hydraulic Sewage Ejector on Lake Ave. South, Duluth, Minn. E. A. Wilson. Illustrates and describes an apparatus for elevating the sewage from a low district, explaining the conditions it was designed to meet. 1300 w. Eng Rec—March 9, 1907. No. 82865.

Regulations for Sewage and Roof Water Disposal on Unsewered Premises, Havana, Cuba. Gives some interesting regulations providing for the construction of miniature septic tanks and of absorbing basins for rain water, pending the completion of a new sewerage system at Havana. 1000 w. Eng News—March 14, 1907. No. 83136.

Municipal Sewage Experiment Stations. Editorial discussion of the progress made in sewage treatment, with suggestions for subjects still needing investigation in connection with this work. 3000 w. Eng News—Feb. 28, 1907. No. 82675.

The Experimental Sewage Treatment Works for Baltimore, Md. Illustrated detailed description of an experimental plant being installed to gain information for use in designing proposed sewage works for the city. 1200 w. Eng News—Feb. 28, 1907. No. 82673.

The Municipal Sewage Experiment Station, of Waterbury, Conn. William Gavin Taylor. Describes the local conditions which must be met, and gives an illustrated description of an experiment station and testing work being carried out. 4500 w. Eng News—Feb. 28, 1907. No. 82674.

Examination and Purification of Sewage (Abwasserfrage und Abwasserreinigung). A. Nolte. System of treatment in use in Cologne and other cities of Europe described. Illus. Serial. 2 parts. 5100 w. Stahl u Eisen—Jan. 23 and 30, 1907. No. 82950 each D.

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The Sewage Disposal Works at Kirksville, Mo. Plan and description of a system carrying domestic sewage only. The disposal works consist of septic tanks, contact beds, and intermittent sand filters, and one bed is sterilized by a solution of copper sulphate before being discharged. 1800 w. Eng Rec—March 23, 1907. No. 83222.

Sewers.

The Bronx Storm Relief Sewer Tunnel. A sewer under construction from Webster Ave. to the Harlem River is illustrated and described. 4000 w. Eng Rec—March 2, 1907. No. 82721.

WATER SUPPLY.

Analysis.

The Use of Lactose Bile Media in Water Analysis. Daniel D. Jackson. Abstract of a paper read before the Am. Pub. Health Assn. Concludes that by the employment of this new media more definite results on the sanitary quality of a water may be obtained than by any other test at present in use. It is also especially valuable in the testing of filter plants. 1000 w. Eng News—March 14, 1907. No. 83131.

Colorado River.

The Lower Colorado River and the Salton Basin. C. E. Grunsky. Information based on official reports upon results of examinations made of the Colorado River's low-water course; and an account of the attempt to turn the river back into its proper channel after its overflow into the Salton Basin. Ills. 18200 w. Pro Am Soc of Civ Engrs—Feb., 1907. No. 83037 E.

Dams.

Technical Conditions Determining the Design of Dams (Norme techniche che dovrebbero presiedere al connaudo dei muri di sbarramento). Domenico Barsanti. Diagram. 2500 w. L'Elettricita—Jan. 25, 1907. No. 82902 D.

Filtration.

The Mechanical Filters of the Water Works of Harrisburg, Pa. Describes some of the leading features and methods of operation. Ills. 6500 w. Eng Rec—March 9, 1907. No. 82864.

Freezing.

The Freezing of Water Plugs (L'Incongelabilité des Bornes-Fontaines). A. Bergés. Methods of preventing freezing of water plugs and types of apparatus designed for this purpose. Ill. 2500 w. Génie Civil—Mar. 9, 1907. No. 82977 D.

Germany.

Water Economy and Storage in Germany (Die Wasserwirtschaft und der Talsperrenbau in Deutschland). Emil Grohmann. Review of different sources of water supply, and location of dams. Illus. 2200 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Feb. 16, 1907. No. 82929 D.

Irrigation.

Irrigation and the Government Irrigation Project at Yuma. Prof. Oscar C. S. Carter. Reviews the early history of irrigation in various parts of the world, and describes the conditions in the semi-arid and arid regions of the United States, and the irrigation projects under consideration and construction, with information relating to the Yuma project. Ills. 7000 w. Jour Fr Inst—March, 1907. No. 83171 D.

The Minidoka Irrigation Project, U. S. Reclamation Service. C. J. Blanchard. Illustrated description of the dam and distributing system of this reclamation work in Idaho. 3000 w. Eng Rec—March 2, 1907. No. 82713.

Isolated House.

Water Supply for the Farm Home. Elmina T. Wilson. Extract from a Bul. of the U. S. Dept. of Agriculture, relating to the water supply of farm homes. 3000 w. Met Work—March 30, 1907. No. 83319.

Pennsylvania.

The Work of the Pennsylvania Water Supply Commission. An account of the work undertaken by this commission, what has been accomplished, etc. 3300 w. Eng Rec—March 16, 1907. No. 83067.

Pipe Lines.

Methods Employed in Laying Three Submerged Pipe Lines. Frederick S. Wardwell. Read before the Conn. Soc. of Civ. Engrs. Describes the methods of laying outfall pipes at Stamford and at Shippan Point, and a pipe across the Housatonic River, at Shelton, Conn. 2000 w. Engng-Con—March 6, 1907. No. 82784.

A 48-in. Riveted Steel Pipe Line at Kansas City, Mo. C. K. Allen. An account of difficulties encountered in laying these large water pipes, describing and illustrating methods of construction. 2000 w. Eng Rec—March 2, 1907. No. 82730.

Pollution.

Report on the Pollution of the Water Supply of Philadelphia by Coal Wastes. Gives the report of Messrs. Fairchild and Gilchrist on coal dirt pollution. 2000 w. Eng News—March 21, 1907. No. 83204.

Contamination of the Water Supply of the City of Breslau (Uebelstände in der Grundwasserversorgung der Stadt Breslau). A. Friedrich. Discussion of the analysis and suggestions for improvement. 1200 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Feb. 9, 1907. No. 82936 D.

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Purification.

Contractor's Plant and Methods Water Purifying and Softening Works, Columbus, Ohio. George E. Howe. An illustrated general description of a pumping station to house the pumps to be used for supplying the purifying and softening works with water and to deliver water from them to the city. 2200 w. Eng Rec—March 2, 1907. No. 82727.

Water Purification at Fostoria, O. Illustrations, with description of a recently constructed sand filter, taken from a paper by W. J. Sherman. 700 w. Eng Rec—March 23, 1907. No. 83219.

Reclamation.

The Reclamation of the North Platte Valley. W. S. Coulter. An illustrated description of the North Platte irrigation project. 1800 w. Pop Sci M—April, 1907. No. 83279 C.

Reservoirs.

The Cobb's Hill Reservoir, Rochester, N. Y. Illustrates and describes the concrete work of a 140,000-gal. reservoir now under construction. 4000 w. Eng Rec—March 2, 1907. No. 82717.

Siphon.

Reinforced Concrete Siphon of the Rio Sosa, Spain (Siphon en Beton Armé du Rio Sosa). Henry Martin. A siphon system for supplying 370 cubic feet of water a second for irrigation projects in Spain. Ill. 5800 w. Génie Civil—Mar. 16, 1907. No. 82971 D.

Sprinkler Systems.

Sprinkler Systems of Fire Protection in the Claflin Store Building, New York. Plans and description of the distribution of heads and arrangement of piping for a 10-story and basement structure. 1600 w. Eng Rec—March 9, 1907. No. 82863.

Water Tunnel.

The Seven-Foot Polk Street Water Tunnel, Chicago. Explains why the new tunnel was necessary and gives an illustrated description of its construction. 3000 w. Eng Rec—March 16, 1907. No. 83065.

WATERWAYS AND HARBORS.

Breakwater.

The Concrete Breakwater at Harbor Beach, Mich. Emile Low. An illustrated description of a new superstructure of concrete being erected on the foundations of an old breakwater. 2500 w. Eng News—March 28, 1907. No. 83320.

Canals.

The Proposed Niagara Ship Canal. Describes present conditions at the western terminus of the Erie Canal, and the proposed improvements of Black Rock harbor and channel. Illustrates the Lobnitz rock-cutter which will be used. 1500 w. Eng Rec—March 16, 1907. No. 83066.

The St. Lawrence Route. S. J. McLean. A review of the canal section, its development and improvement, with information concerning the canal traffic. Map. 2500 w. Ry Age—March 1, 1907. Serial. 1st part. No. 82705.

The Kom-Ombo Irrigation Canal. Illustrated detailed description of interesting work in connection with an extensive irrigation scheme in Egypt. Relates to the supply and erection of a riveted steel canal, about a mile in length, and the supply and erection of two riveted steel rising mains. 2500 w. Engr, Lond—March 8, 1907. No. 83120 A.

Steam Pile and Sheet-Pile Drivers on the New York Barge Canal. Emile Low. Illustrates and describes the pile-drivers and excavators used, and the methods of carrying out the work. 1500 w. Eng Rec—March 2, 1907. No. 82734.

Colorado River.

Closing the New Break in the Colorado River. H. T. Cory. An illustrated description of the break occurring in Dec., 1906, and the method of closing it. 3000 w. Eng Rec—March 2, 1907. No. 82732.

Floating Derrick.

Forty Ton Floating Derrick (Schwimmkran von 40 t. Tragfähigkeit). Adolf Beran. A self-propelling floating derrick for use in and about harbors. Illus. 1700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 2, 1907. No. 82916 D.

Haulage.

Electric Haulage on Canals. An outline of the evidence given by E. W. Marchant on behalf of the London Chamber of Commerce to the Royal Commission on Canals and Inland Waterways. 3500 w. Elec Engr, Lond—March 15, 1907. No. 83264 A.

Loire.

Attempts to Regulate the River Loire (Essais d'Aménagement de la Loire). Ch. Dantin. An illustrated account of the attempts that have been made to make the Loire fit for navigation between Nantes and the confluence of the Maine. Ill. 5000 w. Génie Civil—Feb. 2, 1907. No. 82987 D.

Mississippi Valley.

"Fourteen Feet Through the Valley." Harry B. Hawes. Discussing the project of constructing a 14-ft. channel from Lake Michigan through the Mississippi River to the Gulf. 4000 w. Jour Assn of Engng Soc's—Feb., 1907. No. 83041 C.

Sea Defences.

Ferro-Concrete Sea Defences. Illustrates and describes a system of defence which is said to have proved very successful in Holland. 2000 w. Engr, Lond—March 1, 1907. No. 83001 A.

Teltow.

Electric Installations on the Teltow

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Canal (Les Installations Electrique du Canal de Teltow). Georges Dary. This first article of the series describes the Canal, the country through which it passes and especially the locks. Ill. Serial. 1st part. 1800 w. L'Elec—Feb. 16, 1907. No. 82996 D.

Tiber.

Improvement Work on the Tiber (I Lavori del Tevere). G. Como. A description of the work to improve navigation on the Tiber and to protect its banks. Map. 6000 w. Rivista Marittima—Feb., 1907. No. 82979 E + F.

Waterways.

A Plea for the Development of the Waterways. Hon. Joseph E. Ransdell. Address delivered before the Upper Mississippi Improvement Association. 7000 w. Marine Rev—March 21, 1907. No. 83209.

Protected Waterway from Boston to the Gulf. Hon. John H. Small. Discusses the movement for the construction by the United States of inland waterways extending from New England along the entire Atlantic seaboard to the Gulf of Mexico. 3500 w. Mfrs' Rec—March 21, 1907. No. 83207.

MISCELLANY.

Drainage.

Drainage of Bottom Lands Along the Mississippi and Missouri Rivers. Gives abstracts of two papers read at meeting of the Illinois Society of Engineers and Surveyors. I. The Sny Island Levee Drainage District, by W. P. Bushnell. II. The Barton East Drainage System, Nebraska, by L. G. Hicks. 3000 w. Eng News—March 14, 1907. No. 83133.

Earthquake.

The Effects of the San Francisco Earthquake of April 18th, 1906, on Engineering Constructions. Reports of a general committee and of six special committees of the San Francisco Association of Members of the Am. Soc. C. E. Ills. 20700 w. Pro Am Soc of Civ Engrs—March, 1907. No. 83329 E.

Engineering.

President's Address before the North-East Coast Institution of Engineers and Shipbuilders. W. H. Dugdale. An interesting summary of engineering from the earliest times, showing the value of scientific and technical institutions. 8500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Jan., 1907. No. 82822 N.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

The Management and Operation of Ship and Shore Wireless Telegraph Stations. A. Frederick Collins. The sixth of a series of articles dealing with the design, construction and operation of a 100-mile wireless telegraph. 2200 w. Sci Am Sup—March 16, 1907. No. 83021.

Recent Practice in Wireless Station Construction. G. H. Barbour. Illustrates and describes various designs of stations for wireless work, especially the masts and their erection. 3500 w. Elec Wld—March 2, 1907. No. 82773.

Controlling Torpedoes by Wireless Telegraphy. Describes a torpedo launching apparatus, operated by electric waves, which has recently been tried in France. Diagrams. 1000 w. Sci Am—March 23, 1907. No. 83151.

Wireless Telegraphy Between Newhaven and Dieppe. Explains conditions which made the establishment of a wireless station desirable, and gives an illustrated description of the station and its equipment. 2000 w. Engng—March 8, 1907. No. 83117 A.

Carborundum and Silicon Detectors for Wireless Telegraphy. A. Frederick Collins. Describes detectors recently brought out by Gen. H. H. C. Dunwoody, and by Pickard. 900 w. Sci Am—March 16, 1907. No. 83019.

Wireless Telegraph Receivers. S. M. Kintner. Discussing improvements made in detectors, especially commending the liquid barretter and its various modifications. 1800 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83024 D.

Telephony.

Telephone Retrospection. W. D. Sargent. Brief review of the development. 1800 w. Elec Rev, N Y—March 9, 1907. No. 82877.

The Storage Battery in Telephony. C. E. Paxson. Considers the methods of design of central office storage batteries from the point of messages. 2000 w. Elec Wld—March 16, 1907. No. 83127.

Multiple Control Arrangement for the Nuremberg-Fürth Telephone Line (Vielfach Umschalte Einrichtungen für die Fernsprech Anlage Nürnberg-Fürth). J. Jacob. Detailed description. Illus. Serial. 2 parts. 8600 w. Elektrotechnische Zeitschrift—Feb. 14 and 21, 1907. No. 82963 each B.

Telharmonium.

The Telharmonium—An Apparatus for the Electrical Generation and Transmission of Music. An illustrated description

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of the New York plant embodying the system of Dr. Thaddeus Cahill. 2200 w. Sci Am—March 9, 1907. No. 82808.

The Telharmonic System of Producing Music Electrically. Illustrates and describes the telharmonium, an electrical machine for the production of music, and the system of distribution. 1000 w. Eng News—Feb. 28, 1907. No. 82672.

DISTRIBUTION.

Cables.

Underground Transmission and Distribution of Electrical Energy. Charles E. Phelps. A brief study of the faults in cables, showing that most of them can be avoided. 1600 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83047 D.

Conduits.

Installing Feeder Conduits in Fireproof Buildings. T. W. Poppe. Calls attention to points needing care. Ills. 900 w. Elec Wld—March 2, 1907. No. 82776.

Faults.

Localization of Faults on a Three-Wire Network. F. Fernie. Briefly describes methods used with success. 2000 w. Elec Rev, Lond—March 15, 1907. No. 83266 A.

Insulation.

Electric Strength and Resistance of Two Different Insulating Materials in Contact (Elektrische Kraft und Durchschlagsfestigkeit in zwei hintereinander geschalteten Isolierstoffen). Gustav Benischke. Diagrams and formulæ. 1500 w. Elektrotechnische Zeitschrift—Jan. 31, 1907. No. 82939 B.

Insulators.

New Methods of Fastening Insulators. Carl Egner. Translated from the *Teknisk Tidskrift*. Illustrated description of this new method, the essential part being the use of insulating caps of extra strong, durable paper, impregnated with insulating material. 1200 w. Elect'n, Lond—March 8, 1907. No. 83110 A.

Switchboards.

Some Aspects of Modern Switchboard Engineering. C. W. Stone. Read before the N. Y. Elec. Soc. Aims to point out some undesirable features to avoid, and to explain why some things are done. Ills. 5000 w. Elec Rev, N Y—March 9, 1907. No. 82880.

A General Solution of Change-Over Switch Problems. Frank M. Denton. Suggests a practical general solution of the problem of changing over from one diagram of connections to another, by means of throw-over switches, using the smallest possible number of blades and contracts. 500 w. Elec Wld—March 23, 1907. No. 83239.

Remote Control High-Tension Switch Gear. Frank Walker. Abstract of a paper read before the Glasgow Loc. Sec. of the Inst. of Elec. Engrs., containing a description of the L. C. C. tramways, Greenwich power station switch gear. Ills. 3000 w. Mech Engr—March 2, 1907. Serial. 1st part. No. 82889 A.

DYNAMOS AND MOTORS.

Alternating Current.

Alternating Current Machine with Separately Excited Field (Wechselstrom Maschine mit Hilfsfeld und verketteter Erreger Maschine). A. Heyland. Theoretical treatment of the action of such machines. Diagrams and table. 7800 w. Serial. 2 parts. Elektrotechnische Zeitschrift—Feb. 7 and 14, 1907. No. 82961 each B.

Armature Reaction.

Effect of Armature Reaction in Synchronous Motors and Rotary Converters. B. T. McCormick. States the laws upon which the diagram depends, and explains the construction of the general synchronous motor diagram and the rotary converter. 1500 w. Can Soc of Civ Engrs—March 14, 1907. No. 83288 N.

Heating.

Researches on the Heating of Armatures and Field Coils. Ludwig Ott. Illustrated description of experiments carried out in the Munich Technical High School. 2200 w. Elect'n, Lond—March 8, 1907. No. 83111 A.

The Iron Losses in Asynchronous Machines. Thomas F. Wall. The losses in these machines are mentioned, with special reference to the pulsation of the flux in the teeth. Experiments are described. 2000 w. Elect'n, Lond—March 1, 1907. Serial. 1st part. No. 82892 A.

Principles.

Elementary Principles of Dynamos. Clarence Renshaw. Explanation, with diagrams. 700 w. Ry & Loc Engng—March, 1907. No. 82703 C.

Railway Motors.

The Anatomy of a Railway Motor and Control Equipment. James Lyman. Gives briefly the fundamental principles governing electricity and magnetism, and their application to the railway motor and controlling equipments, discussing train control and related topics. Ills. Discussion. 10700 w. Pro W Ry Club—Feb. 19, 1907. No. 83158 C.

The Inter-Pole Railway Motor. C. A. Mudge. Explains the advantages of the use of inter-poles in railway motors. 2000 w. Elec Wld—March 9, 1907. No. 83014.

Large Single Phase A. C. Locomotive Motor (Grosser Lokomotivmotor für Einphasen-Wechselstrom). E. C. Zehme. A 300 h.p. motor of the Eichberg-Winter type. 350 w. Elektrotechnische Zeitschrift—Feb. 7, 1907. No. 82960 B.

Single Phase.

Slip, Torque and Stator Loss in Single-

We supply copies of these articles. See page 216.

Phase Motors (Schlüpfung, Drehmoment und Statorverluste des Einphasenmotors). Adolf Thomälen. Mathematical treatment. Diagrams and formulæ. 2100 w. Elektrotechnische Zeitschrift—Feb. 28, 1907. No. 82966 B.

Windings.

Calculation of Auxiliary Pole Windings. Arthur Keller. Explains the calculation of the ampere-turns required to produce the commutating fluid. 2000 w. Elec Wld—March 9, 1907. No. 83016.

A Method of Calculating the E. M. F. of Polyphase and Single-Phase Windings. H. Görges. Abstracted from *Elektrotechnische Zeitschrift.* The author establishes an ampere-turn vector diagram by means of which the space wave-shape of the magnetic flux, and the flux through each tooth, may be determined at any instant. 1500 w. Elect'n, Lond—March 1, 1907. No. 82893 A.

ELECTRO-CHEMISTRY.

Accumulators.

Experiments on the Distribution of Current in Accumulators. U. Schoop. Abstract translation. A study of the distribution of current in accumulators, and the way in which the electrolyte conducts the current, especially the action of the "electrolytic shunt." 2200 w. Elect'n, Lond—March 1, 1907. No. 82894 A.

Black-Nickel.

Deposition of Black-Nickel in the Plating Barrel. Wilbur G. Stratton. An account of methods that gave a satisfactory deposit. 700 w. Brass Wld—March, 1907. No. 83284.

Copper Peroxide.

Production of Peroxide of Copper by Electrolysis (Bildung von Kupferperoxyd durch Elektrolyse). E. Muller and F. Spitzer. Diagram. 1600 w. Zeitschr für Elektrochemie—Jan. 25, 1907. No. 82915 G.

Electrolysis.

Alternating-Current Electrolysis. J. L. R. Hayden. A report of investigations made to determine to what extent alternating currents passing between any metallic conductor and the ground would produce electrolytic corrosion. Gives conclusions. 5800 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83043 D.

Electroplating.

The Electrodeposition of Brass and Bronze and the Maintenance of the Solutions. Reviews the history of brass plating and gives much information. 3000 w. Brass Wld—March, 1907. Serial. 1st part. No. 83283.

Soldered Nickel Anode Hooks. Paul Johnson. Explains the advantage of soldering the anodes and method of doing it. 600 w. Brass Wld—March, 1907. No. 83282.

Energy.

Electrical and Chemical Energy. Gustaf M. Westman. Makes a comparison between the kinetic energy of gases and the electric current, and shows the relation between chemical and electrical energy, considering also how the current is conducted. 2500 w. Jour Fr Inst—March, 1907. No. 83170 D.

Nitrogen.

Fixation of Atmospheric Nitrogen. Abstract translation of portions of a paper by Dr. Georg Erlwein, published in *Elektrotechnische Zeitschrift.* Deals with researches in this field, and the processes relating to the manufacture of calcium cyanamide, discussing its practical applications. Ills. 2500 w. Elec-chem & Met Ind—March 10, 1907. No. 82871 C.

Fixation of Atmospheric Nitrogen by Calcium Carbide (La Fixation de l'Azote atmosphérique par le Carbure de Calcium). Henri Demierre. Brief description of the process. 1600 w. Bulletin Technique de la Suisse Romande—Jan. 25, 1907. No. 82914 D.

ELECTRO PHYSICS.

Alternators.

Magnetic Oscillations in Alternators and Their Bearing Upon the Design. G. W. Worrall. Gives results of a series of experiments made to determine the amount of the oscillations of magnetic flux in the poles of alternators, and also in the interpolar space. 2000 w. Elect'n, Lond—Feb. 22, 1907. No. 82828 A.

Conduction.

Electric Conduction in Metals. Abstract of a lecture by J. J. Thompson before the Inst. of Elec. Engrs. An account of the modern theory and the results thus far accomplished. 3500 w. Engng—March 1, 1907. No. 82898 A.

Conductivity.

The Modern Theory of Electrical Conductivity of Metals. Prof. J. J. Thomson. Lecture before the Inst. of Elec Engrs. Gives the electron or corpuscle theory of electrical conduction in metals, and an explanation of the Hall effect. 5500 w. Elec'n, Lond—March 15, 1907. No. 83267 A.

Conductors.

Some Newly Observed Forces Within an Electric Conductor. Abstract of a paper by Dr. E. F. Northrup giving a summary of experiments made and conclusions reached. Also editorial. 2500 w. Elec Wld—March 9, 1907. No. 83017.

Divided Circuits.

Theory of Alternating Currents in Divided Circuits (Zur Theorie der Wechselstrom Verzweigung). Leo Lichtenstein. Mathematical treatment. Diagrams and formulæ. 4400 w. Elektrotechnische Zeitschrift—Feb. 7, 1907. No. 82958 B.

We supply copies of these articles. See page 316.

Electric Waves.

Ionized Gas Electric Wave Detectors. C. Tissot. Translated from the *Jour. de Physique*. An account of experimental investigations. 1800 w. Elect'n, Lond—Feb. 22, 1907. No. 82829 A.

Apparatus for Measuring Electric Wave Lengths (Construzione Di Un Cumometro Per Radiotelegrafia). P. Barreca. Ills. 3500 w. Rivista Marittima—Nov., 1906. No. 82904 E + F.

Oscillographs.

Investigation of High-Frequency, High Potential Oscillating Discharges by Means of the Braun Tube. E. L. Weber. Describes an experiment for the purpose of obtaining a direct graph of the wave form of a high-frequency, high-potential oscillating discharge, by using the Braun cathode ray tube. Short editorial. 1500 w. Elec Wld—March 9, 1907. No. 83015.

X-rays.

The Roentgen Ray and Its Uses. E. W. Caldwell. Reviews some of the results accomplished, giving a statement of the appliances and methods used. 2200 w. Elec Rev, N Y—March 9, 1907. No. 82878.

GENERATING STATIONS.

Accumulators.

The Soulier Apparatus for Charging Accumulators by Means of Alternating Current (L'Appareil á Charger les Accumulateurs au moyen de Courants Alternatifs). H. Fontaine. Illustrated description. 1800 w. Bull de la Soc d'Encour. Feb., 1907. No. 82974 G.

Alternators.

Alternator Troubles. A. E. Buchenberg. Discusses troubles due to excessive heating and poor voltage regulation of electrical machines. 2000 w. Elec Wld —March 2, 1907. No. 82775.

Balancing.

The Balancing of the Greenwich (L. C. C.) Engines. W. E. Dalby. Gives facts concerning the vibrations produced by the engines installed, taken from the report of the Committee appointed to inquire into the working of the generating station at Greenwich, in its relation to the Royal Observatory. 1700 w. Prac Engr—March 1, 1907. No. 82885 A.

Breakdowns.

Breakdowns of Electrical Machinery. Llewellyn Foster. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Calls attention to the commoner forms of breakdown occurring more particularly in continuous-current machines. Considers the stationary parts carrying current, and not carrying current; and the moving parts carrying, and not carrying current. 3800 w. Mech Engr—March 9, 1907. No. 83105 A.

Economics.

Central Station Supply Economics; Their Study, and What It Promises in the Way of Cheaper Supply. A. M. Taylor. Paper read before the Birmingham Loc. Sec. of the Inst. of Elec. Engrs. Gives a method of separating running charges from fixed charges, showing how to divide the costs. Considers the effect of internal diversity factor, and suggests a method of using accumulators. 7700 w. Elect'n, Lond—Feb. 22, 1907. No. 82826 A.

Generators.

Introduction to Discussion on the Practicability of Large Generators Wound for 20,000 Volts. B. A. Behrend. Principally a consideration of steam-turbine generators for large capacity, 7,500 kw. to 1,500 kw. and above. 1000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83050 D.

Hydro-Electric.

Electric Transmission System of the York Haven Water and Power Company. Illustrated description of a large power development on the Susquehanna River. Some of the unusual features are the arrangement of the turbines and the crossing of the river by high-tension cables laid in the river bed. 3500 w. Elec Wld—March 2, 1907. No. 82771.

The Highest Hydro-Electric Transmission Plant in the World. Brief illustrated description of the plant for working the Caylloma silver mines, in Peru. 1400 w. Min Jour—Feb. 23, 1907. No. 82831 A.

The Hydro-Electric Plant of the Towaliga Falls Power Co., Griffin, Ga. Illustrates and describes a water power development by which some 3,000 h. p. are rendered available from a stream having a minimum flow of 100 second-feet. 2500 w. Eng Rec—March 9, 1907. No. 82862.

The Shawinigan Hydro-Electric Power Plant. Wallace C. Johnson. An account of the latest developments and extension of the great station at Shawinigan Falls, Canada. Maps and Ills. 2000 w. Cassier's Mag—March, 1907. No. 83028 B.

Isolated Plants.

Regulation in Isolated Plants. Dr. Louis Bell. Gives records of voltage tests made on four typical isolated plants, and also a voltage curve from central station service, with comments. 1200 w. Elec Wld—March 2, 1907. No. 82772.

Neasden.

The Generation of Power at Neasden. A statement of the technical and economic results of the working of this station of the Metropolitan Railway, describing the methods. 4000 w. Engr, Lond—March 1, 1907. No. 83003 A.

Niagara.

Power Development at Niagara Falls (Utilisation des Chutes du Niagara).

We supply copies of these articles. See page 316.

Henry Arban. Describes the generating stations, distribution systems and transmission lines of the Niagara Falls Power Company and the Ontario Power Company. Ills. 3500 w. Soc Belge d'Elec—Feb., 1907. No. 82989 F.

Power Plants.

New Power Plant of the Potomac Electric Power Co. of Washington, D. C. Illustrated detailed description of a recently completed 10,000-kw. plant having a concrete building and steam-turbine units. 3500 w. Eng Rec—March 16, 1907. No. 83072.

The Long Island City Power Station. A. D. Williams, Jr. An illustrated detailed description of one of the stations which will furnish power to operate the Pennsylvania R. R. tunnel under New York City. 3800 w. Engr, U S A—March 15, 1907. No. 83092 C.

Friedenau Electric Power Station (Das Elektrizitatswerk der Gemeinde Friedenau bei Berlin). Max Mulertt. A station operated by two Diesel engines of 300 h. p. each. Ills. 1400 w. Elektrotechnische Zeitschrift—Feb. 7, 1907. No. 82959 B.

Rhine.

The Water-Powers of the Rhine Near Laufenburg. Illustrated description of proposed utilization of the Rhine; which will prove one of the most important water-power plants on the European Continent. 1500 w. Engng—March 8, 1907. No. 83114 A.

Shops.

Shops of the New York Edison Company. Illustrates and describes some of the equipment of shops for central station repair work. 1800 w. Elec Wld—March 23, 1907. No. 83238.

Smoke.

The Influence of Central-Station Loads on Smoke Production. Dr. Charles E. Lucke. Gives data from two large stations in every-day operation, with a brief record of results which seem to indicate that continuous smokeless fuel combustion is impossible with rapid load fluctuations. 5000 w. Power—March, 1907. No. 82656 C.

Turbine Plant.

The New Steam Turbine Plant of the Potomac Electric Power Company, Washington, D. C. Illustrated description of a modern power plant of large size employing steam turbines as prime movers. 3000 w. Elec Rev, N Y—March 2, 1907. No. 82683.

Yellowstone.

Water Power Development in the Yellowstone Valley. G. A. Wheeler. Explains the conditions in this valley, showing that the question of water power resolves itself into low pressure plants of comparatively small output, and gives an illustrated description of such a plant. 2500 w. Sib Jour of Engng—March, 1907. Serial. 1st part. No. 83286 C.

Zambesi River.

Power Development of the Falls of the Zambesi River (L'Utilisation des Chutes du Zambèze). A description of the Victoria Falls and of the power developments which are to be made. 1400 w. L'Elec—Feb. 2, 1907. No. 82999 D.

LIGHTING.

Arc Lamps.

Flame Arc Lamps. H. S. Hatfield. Discusses the advantages of these lamps and illustrates and describes the design of Mr. Frank Lewis, its construction and control. 1800 w. Elect'n, Lond—March 15, 1907. No. 83268 A.

The Arc as a Source of Light. Elihu Thomson. Considers briefly the ways in which the electric flux known as an arc may produce light and the efficiency. 2500 w. Elec Rev, N Y—March 9, 1907. No. 82876.

History.

A History of Gas and Electric Lighting. M. E. Cornuault. Presidential address before the Société des Ingenieurs Civils de France. 4000 w. L'Elec—Feb. 2, 1907. No. 82998 D.

Illumination.

Light and Illumination. Charles P. Steinmetz. Read before the New York Section of the Ill. Engng. Soc. A study of the problems of effective illumination. 10,000 w. Pro Age—March 15, 1907. No. 83006.

Incandescent Lamps.

The New Types of Incandescent Lamps. A. Libesny. Abstract translation. Considers some of the newer types of lamps, and their increased efficiency, discussing the problems involved. 1800 w. Elect'n, Lond—March 1, 1907. No. 82895 A.

Electric Lighting by Incandescence. William J. Hammer. A review of the early work and the development, and the recent work with metallic filament lamps. 3500 w. Elec Rev, N Y—March 9, 1907. No. 82879.

Determination of the Average Horizontal Intensity of Incandescent Lamps (Uber die Bestimmung der mittleren Horizontal Lichtstärke von Glühlampen). F. Uppenborn. Discussion of different kinds of photometers and tabulation of the results of tests. Ills. Serial. 2 parts. 4800 w. Elektrotechnische Zeitschrift—Feb. 14 and 21, 1907. No. 82962 each B.

Mercury Vapor.

The Uviol Lamp. An illustrated description of a modification of the Hewitt mercury vapor lamp, for producing ultraviolet rays. 1000 w. Sci Am—March 9, 1907. No. 82809.

We supply copies of these articles. See page 316.

Projectors.

Improvements in Projectors. John I. Hall. Deals with the utilization of ordinary dispersion lenses of projectors to fulfil the requirements of the Suez Canal regulations, which stipulate that searchlights shall have a shadow in the center of 5° divergence. 1000 w. Elec Rev, Lond—March 1, 1907. Serial. 1st part. No. 82891 A.

Train-Lighting.

Train-Lighting. H. Henderson. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. The present number is largely a discussion of electric lighting for trains, and its advantages, cost, etc. Ills. 3000 w. Elec Engr, Lond—March 8, 1907. Serial. 1st part. No. 83108 A.

Tungsten.

The New Tungsten Lamps (Les nouvelles Laumes Electriques au Tungstene). M. Bainville. A discussion of the manufacture and practical value of the Tungsten filament lamp. Discussion. 3800 w. Bull Soc Int d Elecs—Feb., 1907. No. 82982 F.

MEASUREMENT.

Insulation.

Measurement of Wire and Cable Insulation. F. Wachter. Explains possible methods of obtaining the correct insulation resistance per mile of a certain wire or cable. 700 w. Elec Wld—March 23, 1907. No. 83240.

Meters.

Meter Testing. Oliver J. Bushnell. Considers the necessity of testing, the frequency, installation tests, and methods of testing. 3500 w. Can Elec News—March, 1907. No. 83194.

New Electricity Meter (Un Nuovo misuratore eléttrico). G. B. Picecco. Ills. 600 w. L'Elettricita—Jan. 18, 1907. No. 82901 D.

Pyrometry.

Optical Pyrometry. Gives an abstract of results of researches carried out by the Bureau of Standards of the United States Government. Ills. 6500 w. Engng—March 1, 1907. Serial. 1st part. No. 83000 A.

TRANSMISSION.

Direct Current.

The Transmission of Electrical Energy by Direct Current on the Series System. J. S. Highfield. Shows that M. Thury has carried the direct-current series system far beyond the experimental stage and has made great advancement in the improvement of direct-current generators and motors and in the use of very high pressures. Describes the system and gives information regarding cost. Ills. 9600 w. Inst of Elec Engrs—March 7, 1907. No. 83109 N.

High-Tension.

High-Tension Outlets. Alvin Meyers. An illustrated article describing work for the Telluride Power Co., tests carried out, and the design of bushing to meet stated requirements, giving specifications for constructing and installing 44,000-volt outlet bushings. 3800 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83046 D.

Hydro-Electric.

Electric Power Transmission. Frederick Darlington. A discussion of the qualities that chiefly affect the value of water powers, and the classes of loads to which they are applied, their development, etc. 2500 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83025 D.

Long Distance.

Motor-Generators vs. Synchronous Converters, with Special Reference to Operation on Long-Distance Transmission Lines. P. M. Lincoln. A paper introductory to a discussion of this subject, making a comparison of reliability, voltage regulation, corrective effect, efficiency, cost, parallel operation and starting. 1000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83049 D.

MISCELLANY.

"Energy Car."

"The Energy Car" ("L'Energy-Car"). H. Tudor and M. Braun. A truck fitted with gas engine, generator and battery of accumulators which is in reality a movable central station for small supplies of current. Ills. 3800 w. Soc Belge des Elecns—March, 1907. No. 82975 F.

Oil.

Drying Transformer Oil. R. B. Treat. Considers tests for determining moisture in oil and methods of removing it without harm to the oil. 1000 w. Elec Wld—March 2, 1907. No. 82774.

Protection.

Discussion on "Recent Investigation of Lightning Protective Apparatus" at New York, December 28, 1906. Discussion of R. P. Jackson's paper on this subject. 10800 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83048 D.

Review.

What Hath Been Wrought. William Hand Browne, Jr. A review of a quarter of a century's progress in the application of electricity, with portraits of men connected with the work. 7000 w. Elec Rev, N Y—March 9, 1907. No. 82875.

Transformer.

The De Faria Electrolytic Transformer (Transformateur Electrolytique, système O. de Faria). J. A. Montpellier. Description of an apparatus for transforming alternating into direct current on a small scale, especially adapted to laboratory use. Ill. 300 w. L'Elecn—March 2, 1907. No. 82980 D.

We supply copies of these articles. See page 376.

INDUSTRIAL ECONOMY

Accounting.

Brass Foundry Cost Accounting. D. Carl Eggleston. Outlines a system used. 1000 w. Foundry—March, 1907. No. 83182.

Channel Tunnel.

The Channel Tunnel. Translated from *L'Illustration*. Reviews the projects at various times for constructing a tunnel under the English Channel. 2000 w. Sci Am Sup—March 9, 1907. No. 82811.

Chemistry.

The Industrial Outlook for Physical Chemistry. Alfred Sang. Showing the important bearing of chemical research as applied to the industries. 6000 w. Pro Engrs' Soc of W Penn—Feb., 1907. No. 83036 D.

Coal Reserves.

How Long Will the Coal Reserves of the United States Last? Marius R. Campbell. Discusses the formation of coal, the production, distribution, estimated amount in the United States, etc. Also a short article on "Efforts to Obtain Greater Energy from Coal." 5000 w. Nat Geog Mag—Feb., 1907. No. 82661 C.

Cost Systems.

Cost Reduction Through Cost Comparison. C. E. Knoeppel. This second article of a series considers the treatment of machine, part, group, and operation costs. 1700 w. Engineering Magazine—April, 1907. No. 83315 B.

Labor: Premium System. F. E. Webner. The seventh of a series of articles on cost-keeping. 3300 w. Ir Trd Rev—March 7, 1907. No. 82787.

Education.

Engineering Education. Arthur J. Rowland. Some remarks on the proper scope of engineering education, particularly electrical engineering. 2000 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83022 D.

Technical Foundry Education. H. E. Field. Read before the N. Eng. Found. Assn. Criticizes the methods taught and suggests a new course which will specialize in foundry practice. 3500 w. Foundry—March, 1907. No. 83176.

Technical Instruction in the United States (Instruction Industrielle Technique aux Etats-Unis d'Amérique). Dr. H. Schacht. The conclusions formed by Prussians who have investigated the subject. 6000 w. Rev Econ Inter—Feb., 1907. No. 82995 E + F.

German Technical Schools (Les Ecoles Techniques Allemandes). André Pelletan. Comprehensive account of the courses of study, laboratories, equipment, degrees conferred, etc. Tables and diagrams. 11,500 w. Bull De La Soc D'Encouragement Pour L'Ind Nat—Original Memoirs—Dec. 1, 1906. No. 82912 E + F.

The Marine Engineer, English and Foreign: His Training and Education. H. Bithel-Jones. Examines conditions existing in Germany, Denmark, Norway and Sweden, comparing with the conditions of British engineers. 5000 w. Marine Rev—March 7, 1907. No. 82814.

Engineering Laboratories of the University of Pennsylvania. An illustrated detailed description of these laboratories and their equipment. 9800 w. Ry & Engng Rev—March 23, 1907. No. 83250.

Gold Standard.

The Increased Production of Gold and Its Relation to the Standard of Value. Alexander E. Outerbridge, Jr. A discussion of the effect of the increased production of gold. Thinks the increase has failed to keep pace with the expansion of trade and increase in value of other products, and that there is no reason to fear its decline. 3000 w. Cassier's Mag—March, 1907. No. 83027 B.

Labor.

A Plan to Provide a Supply of Skilled Workmen. M. W. Alexander's paper on this subject is discussed. 5000 w. Pro Am Soc of Mech Engrs—March, 1907. No. 83169 C.

The Risks of the Trade. James P. Wilson. A discussion of the employer's liability law, especially in its relation to railway employees. General discussion. 10,000 w. Pro Ry Club of Pittsburgh—Jan., 1907. No. 83280 C.

The Utilization of Labor. Henry L. Gantt. A study of the economical utilization of labor. 5000 w. Stevens Ind—Jan., 1907. No. 83307 D.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This fourth article of a series shows the great importance and value of tool-room reorganization, suggesting methods for realizing the maximum possibilities of the tool-room. 3500 w. Engineering Magazine—April, 1907. No. 83313 B.

Packing.

Proper Packing. From the *Daily Consular and Trade Reports* of the Department of Commerce and Labor. Deals with the handling of machinery and parts for export. 3000 w. Ir Age—March 21, 1907. No. 83140.

We supply copies of these articles. See page 316.

Panama.

New York and Panama. A Contrast in Engineering Achievement. Ernest John Munby. An illustrated account of the extensive work connecting Manhattan with the mainland by numerous tunnels under the rivers, which is being executed under public contract, comparing it with the work at Panama. 4000 w. Engineering Magazine—April, 1907. No. 83310 B.

Shop Practice.

Modern Shop Practice from an Inspector's Standpoint. D. W. M'Naugher. Considers unskilled labor responsible for most of the troubles met. Discussion. 6000 w. Pro Engrs' Soc of W Penn—Feb., 1907. No. 83035 D.

South America.

An Awakened Continent to the South of Us. Elihu Root. An address before the Trans-Mississippi Commercial Congress, Kansas City, Missouri. A discussion of the steps needed to encourage the commerce and trade with South America. 7500 w. Nat Geog Mag—Jan., 1907. No. 83011 C.

U. S. Steel Co.

The United States Steel Corporation's Annual Report. Information of interest from this report, which shows the largest gross and net earnings in its history. 4000 w. Ir Age—March 21, 1907. No. 83142.

MARINE AND NAVAL ENGINEERING

Battleships.

Testing the New Battleship Vermont. An illustrated account of the severe trials made last December during stormy weather. Ills. 1500 w. Naut Gaz—March 7, 1907. No. 82844.

Boilers.

Combustion in Marine Boilers. Peter Youngson. An illustrated description of Howden's forced draught system, with introductory remarks. 3300 w. Marine Rev—March 7, 1907. No. 82812.

Combustion Motors.

Recent Progress in Internal-Combustion Motors for Marine Purposes (Recenti Progressi dei Motori Marini a Combustione Interna). I. D. Cardile. Ills. 15,000 w. Rivista Marittima—Feb., 1907. No. 82997 E + F.

Tendencies and Improvements in Marine Gas-Engine Construction. Howard Greene. Calls attention to progress and gives illustrated descriptions of recent engines modelled on an approach to steam-engine design. 3000 w. Engineering Magazine—April, 1907. No. 83314 B.

Cruiser.

The Trials of the German Turbine Cruiser "Lubeck." A report of the long series of trials to which this first turbine cruiser of the German Navy has been submitted. 1800 w. Engng—Feb. 22, 1907. No. 82837 A.

Docks.

Torpedo Boat Docks at the Kiel Imperial Ship Yard. Dr. Alfred Gradenwitz. Illustrated description of an interesting floating dock plant recently constructed for the docking of torpedo boats. 1200 w. Int Marine Engng—March, 1907. No. 82664 C.

Dry Dock.

New Dry Dock at Lorain. Improvements and extensions at the works of the American Shipbuilding Co. are illustrated and described. 1100 w. Marine Rev—March 7, 1907. No. 82813.

Electricity.

The Application of Electricity to Naval Service (Le Applicazioni dell' Elettricità ai Servizi Navali). E. Simion. A general review of the subject. 30000 w. Rivista Marittima—Feb., 1907. No. 82978 E + F.

German Navy.

The Real Facts About the German Navy. Archibald S. Hurd. An illustrated article giving a comparison between the naval strength of Germany and Great Britain. 5400 w. Cassier's Mag—March, 1907. No. 83026 B.

Lighthouse.

The Racine Reef Lighthouse and Fog Signal in Lake Michigan. Illustrated description of this lighthouse and its construction. 1500 w. Eng Rec—March 23, 1907. No. 83217.

Magnetism.

Polar Diagrams of Magnetic Deviation (Diagramma Polare Delle Deviazioni Magnetiche). E. Ippolito. Method of using a polar diagram for magnetic deviation to shorten navigation calculations. Diagrams and tables. 2900 w. Rivista Marittima—Dec., 1906. No. 82900 E + F.

Motor Boats.

The Motor Boat Show at Madison Square Garden. A. E. Potter. Review of the exhibits at this exhibition in New York City. 2000 w. Sci Am—March 2, 1907. No. 82643.

Naval Architecture.

The Dimensions, Proportions, and Forms of Ships. H. B. Donaldson. A discussion of the effect of different proportions on stability and the effect of consumable stores, and other conditions that may arise during service. Ills. 3000 w. Int Marine Engng—March, 1907. No. 82663 C.

We supply copies of these articles. See page 316.

Propulsion.

The Deformation of Propeller-Blades. William Burlingham. Discusses the best shape of section for a high-speed propeller-blade. Ills. 3000 w. Engng—March 1, 1907. No. 82897 A.

The Gasoline Motor in Shallow-Draft Vessels. An illustrated account of an experiment being carried out by the Thornycroft Company with shallow-draft vessels for freight service. 1000 w. Sci Am—March 30, 1907. No. 83296.

Sailing Vessels.

The Passing of American Square-Rigged Vessels. Discusses the causes that have led to the disappearance of this class of sailing vessels. Ills. 1500 w. Sci Am—March 9, 1907. No. 82807.

Salving.

How Compressed Air Raised a Sunken Ship. The Remarkable Salving of the Steamship "Bavarian." Illustrates and describes methods used in raising this vessel which was stranded near Quebec. 600 w. Sci Am—March 23, 1907. No. 83150.

Steel Steamer.

The Steel Freight Steamer Satilla. Illustrates and describes one of four freight steamers which have attracted interest on account of the arrangement adopted for the cargo spaces and the placing of the machinery. 700 w. Int Marine Engng—March, 1907. No. 82662 C.

Turbines.

The Marine Steam Turbine. J. W. Sothern. Discusses some of the points affecting the efficiency of steam turbines for the propulsion of ships. Diagrams. 2800 w. Naut Gaz—March 14, 1907. No. 83090.

Vibration.

Vibrations in Ships (Schiffsvibrationen). Walter Thele. Comparison of the vibrations set up in the engines of "Amerika," "Kaiserin Auguste Victoria" and "Deutschland." Illustrated by several diagrams. 2200 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 23, 1907. No. 82922 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Army Trains.

Electrically-Driven Target Trains in the German Army. Dr. Alfred Gradenwitz. Illustrations, with short description of trains moved by the Fowler steam traction engines. 800 w. Sci Am—March 2, 1907. No. 82645.

Articulation.

Experimental Investigation of a New Scheme of Articulation of Motor Vehicles. A. W. Brightmore. Discusses the possibilities of front driving, giving an account of investigations of steering for front-driving vehicles. Ills. 3000 w. Auto Jour—March 9, 1907. No. 83099 A.

Boilers.

Boilers for Steam Vehicles. F. Strickland. Brief illustrated descriptions of typical forms of boilers, with special consideration of boilers for steam vans. 3000 w. Auto Jour—March 9, 1907. No. 83100 A.

Britannia.

The 18-24 H.P. Britannia Car. Illustrates and describes details. 1300 w. Autocar—March 16, 1907. No. 83259 A.

Carburetters.

Float-Controlled Carburetters. — New and Old. Explains what happens in the carburetter and induction pipe of an engine at varying speeds, and gives illustrated description of the Gillett-Lehman device. 1700 w. Autocar—March 9, 1907. No. 83104 A.

Commercial Cars.

Coppock One-Ton Commercial Car. Illustrated description of a vehicle built at Marion, Ind. 1200 w. Automobile—Feb. 28, 1907. No. 82671.

Construction.

Limits of Tolerance in Automobile Parts. Thomas J. Fay. Discusses duplication of parts for automobiles, system necessary to meet requirements, metric measurements, etc. 2500 w. Automobile —March 28, 1907. No. 83302.

Cultivator.

A Steam Cultivator. Illustrated description of an interesting machine shown at the Milan exhibition. 500 w. Engr, Lond—March 8, 1907. No. 83121 A.

Exhibition.

Commercial Motor Vehicle Exhibition. Some of the exhibits at the recent exhibition at Olympia are illustrated and described. 5000 w. Engr, Lond—March 15, 1907. Serial. 1st part. No. 83272 A.

Ignition.

Sources of Electric Ignition Current. Charles B. Hayward. The present article considers the chemical and mechanical sources of current in a general way, to be followed by detailed articles on theory and practice. Ills. 3500 w. Automobile —Feb. 28, 1907. Serial. 1st part. No. 82669.

Light Cars.

The 8 H.P. Sizaire & Naudin Light Car. Illustrated detailed description of this car which attracted attention at the

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last Paris Salon. 1300 w. Autocar—Feb. 23, 1907. No. 82824 A.

Motor Plow.

The Castelin Automobile Plow. Describes a new system of plowing by the use of a gasoline motor and a special automobile. Ills. 600 w. Sci Am Sup—March 23, 1907. No. 83155.

Mud Shields.

Keeping the Mud Under Control. Translation from *La Vie Automobile*, giving the experience of a leading French body builder. Ills. 1000 w. Automobile—Feb. 28, 1907. No. 82670.

Omnibuses.

The Dennis Motor Vehicles. Illustrates and describes an interesting exhibit at the Olympia Show, a distinguishing feature being the drive by worm and wormwheel. Also editorial. 3800 w. Engng—March 1, 1907. No. 82899 A.

The 40-45 H. P. Ryknield Motor 'Bus—An All-British Model. Illustrated detailed description of a petrol omnibus exhibited at Olympia. 1500 w. Auto Jour—March 9, 1907. No. 83098 A.

Orleans.

The British-Built Orleans Cars. Illustrated description of 35 h. p. 6-cylinder, and the 40 h. p., 4-cylinder cars. 1200 w. Auto Jour—March 2, 1907. Serial. 1st part. No. 82881 A.

Petrol-Electric.

The British Thomson-Houston Company's Petrol-Electric System for Commercial Vehicles. General remarks on petrol-electric systems, with illustrated description of Thomson-Houston system, which consists of a dynamo driven by a petrol engine, the whole of the engine power being converted by the dynamo into electrical energy, which is transmitted through a controller to two motors driving the road wheels. 2800 w. Elec Engr, Lond—March 8, 1907. No. 83107 A.

Renard Train.

The Renard Road Train. Illustrated description of this train of road vehicles, in which the power from the locomotive is transmitted by a shaft through the train so that each vehicle is independently driven. 800 w. Auto Jour—Feb. 23, 1907. Serial. 1st part. No. 82823 A.

Roydale.

The 18-22 H. P. Roydale Car. Illustrated description of a British car having new features. 2000 w. Autocar—March 2, 1907. No. 82883 A.

Steam Cars.

Steam Cars *versus* Petrol Cars at the A. C. G. B. I. A discussion opened by Frederic A. Coleman, in which he summarized the superior merits of external combustion. 3500 w. Auto Jour—March 9, 1907. No. 83101 A.

The 10-H. P. Bolsover Steam Car. A recently built low-power machine is illustrated and described. It is of the live-axle type. 2200 w. Auto Jour—March 16, 1907. No. 83258 A.

Timing.

Rudiments of Valve and Ignition Timing. Charles B. Hayward. Discusses the elementary requirements of timing, the factors to be considered, influence of valve design, etc. Diagrams. 3800 w. Automobile—March 21, 1907. No. 83193.

Two-Cycle.

A New French Recruit to the Two-Cycle. Translation from *L'Automobile*. Illustrated detailed description of the Dubois two-cycle motor. 1800 w. Automobile—March 28, 1907. No. 83303.

Tyres.

How to Make Vulcanized Tyre Repairs. Illustrates and describes the various means of effecting sound and satisfactory vulcanized repairs to tyre covers and air tubes. 2500 w. Autocar—March 9, 1907. Serial. 1st part. No. 83103 A.

War Cars.

Latest Designs of the Motor in Warfare. W. G. Fitz Gerald. Illustrates and describes recent designs in war automobiles, with comments on their use. 1200 w. Sci Am—March 23, 1907. No. 83149.

Zust.

The Züst 28-40 H. P. Chassis. Illustrated description of this Italian car, calling particular attention to the four-cylinder engine. 1200 w. Autocar—March 9, 1907. No. 83102 A.

COMBUSTION MOTORS.

Alcohol.

Denatured Alcohol. S. Lawrence Bigelow. An interesting article giving information in regard to alcohol, its manufacture, the properties of denaturants, uses of denatured alcohol, costs and prices. 10500 w. Pop Sci M—March, 1907. No. 82660 C.

Denatured Alcohol: Its Production and Uses. Arthur H. Bosworth. Considers the commercial sources of alcohol and the uses to which it may be applied. 3000 w. Yale Sci M—March, 1907. No. 83160 C.

Alcohol as Fuel for Farm Engines. Abstract of a report by the Special Commission, setting forth the conclusions from a series of tests of alcohol and gasoline in small internal combustion engines. 2500 w. Ir Age—Feb. 28, 1907. No. 82652.

Engine.

A New Vertical Internal Combustion Engine. Illustrations and short description of an engine recently patented in England. 700 w. Mech Engr—March 16, 1907. No. 83262 A.

Fuel.

Alkoethine, a Fuel for Gas Engines. Howard Greene. Describes the Barker-

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White system, which consists in vaporizing alcohol in a carbureter of the ordinary gasoline type and passing the vapor, mixed with the proper volume of air, through calcium carbide. 1000 w. Ir Age—March 21, 1907. No. 83141.

An Alcohol-Acetylene Mixture for Internal-Combustion Engines. Illustrated description of an experimental testing plant for making all kinds of tests with a gasoline engine, with an account of the Barker-White system, where a mixture of acetylene gas and alcohol vapor is produced and used in the engine. 1500 w. Sci Am—March 23, 1907. No. 83148.

Kerosene Used in Gasoline Engines. An illustrated explanation of how changes from one fuel to the other may be made by the use of a common mixing valve or exhaust heated vaporizer. 1000 w. Engr, U S A—March 1, 1907. No. 82744 C.

Gas Analysis.

Gas Analysis with Home-made Pipettes. Harry Spurrier. Directions for making the apparatus, the materials required, and how to prepare it for use. Ills. 2500 w. Power—April, 1907. No. 83248 C.

Gas Engines.

Practical Data from Modern Gas Engines. L. L. Brewer. Information concerning fuel, water and oil consumption of representative types and their weight and space requirements. 2000 w. Power—April, 1907. No. 83245 C.

Gas, Gas Engines, and Gas Producers. J. Seton Gray. Points out the merits of the gas producer, comparing steam and producer plants. Ills. 4200 w. Can Soc of Civ Engrs—Feb. 28, 1907. No. 83032 N.

Gas Engine Troubles and How to Overcome Them (Schwierigkeiten im Betriebe der Gasmaschinen und ihre Beseitigung). Fritz Sellge. Describes valve and spark troubles and remedies for them. Ills. 4000 w. Stahl und Eisen—Feb. 13, 1907. No. 82952 D.

New Gas Engine Diagrams. Frank Foster. Describes the construction and use of a modified diagram for reciprocating gas-engine problems, and also a new temperature-pressure diagram for general gas engine problems. 2000 w. Engr, Lond—Feb. 22, 1907. No. 82838 A.

The Providence Gas Engines and Producers. Illustrated description of a horizontal gas engine adapted for operating on gases of low heat value, and of the suction gas producer. 1200 w. Ir Age—March 14, 1907. No. 83009.

Two New Gas Engines. Gives illustrated descriptions of a double-cylinder single-acting engine, and a four-cylinder vertical engine made in Manchester, England. 1000 w. Engr, Lond—Feb. 22, 1907. No. 82842 A.

Gas Turbines.

The Gas Turbine for Automobile Propulsion. W. H. Stuart-Garnett. A discussion of the problems to be solved in connection with combustion turbines, the progress made, and the possibilities of their application for the use named. 3000 w. Cassier's Mag—March, 1907. No. 83029 B.

Ignition.

Effect of Ignition on the Power of an Engine. W. Watson. Abstract of a paper read before the A. C. G. B. I. Gives a record of measurements made by the writer. 1700 w. Auto Jour—March 2, 1907. No. 82882 A.

High-Tension Electric Ignition for Petrol Engines. John A. Davenport. A report of a series of experiments carried out at East London College laboratory, giving results and describing apparatus. 2000 w. Engng—Feb. 22, 1907. No. 82833 A.

Manograph.

The Schultze Manograph for Taking Indicator Cards of Gasoline Engines. Illustrated description of an instrument designed to give an accurate diagram of the pressure obtained in the cylinder of an internal-combustion engine. 1200 w. Sci Am Sup—March 23, 1907. No. 83156.

HEATING AND COOLING.

Cooling Towers.

Cooling Towers. B. Franklin Hart, Jr. Read before the Am. Soc. of Refrig. Engrs. Describes the use of the cooling tower in a refrigerating or ice-making plant and its advantages. Ills. 1500 w. Stevens Ind—Jan., 1907. No. 83309 D.

Furnace Heating.

Proper Heater Location and Duct Area Exemplified. John P. Bird. Illustrated description of a furnace heating system with branching cellar mains and oval flues. Also editorial. 1400 w. Met Work—March 16, 1907. No. 83051.

Heaters.

Heaters for Hot Blast and Ventilation. Charles L. Hubbard. Illustrated descriptions of types of heaters, discussing their efficiency, etc. 2500 w. Mach, N Y—March, 1907. No. 82765 C.

Ice Plant.

Operating an Absorption Machine. William S. Luckenbach. Gives practical details in the operation of an absorption ice plant. 3000 w. Engr, U S A—March 1, 1907. No. 82745 C.

Pipes.

Standardization of Cast-Iron Heating and Ventilating Pipes. Louis F. Pearson. From a paper before the British Inst. of Heat. & Vent. Engrs. An account of the work done by the committee appointed to consider cast pipes. 2200 w. Heat & Vent Mag—March, 1907. No. 83173.

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Refrigeration.

The Commercial Application of Refrigeration. Hal Williams. Showing the large field developed for the application of refrigeration in the industries. General discussion. 8500 w. Jour Soc of Arts—Feb. 22, 1907. No. 82820 A.

Refrigeration on Shipboard. Joseph H. Hart. Reviews briefly the types and methods of refrigerating machines, their efficiency, operation, etc. 3000 w. Cassier's Mag—March, 1907. No. 83031 B.

Absorption Refrigerating Machines. James W. Cooper. Diagrammatic elevation and explanation of how a plant is laid out, giving practical directions for running either a dry or a brine system. 2500 w. Power—April, 1907. No. 83247 C.

Typical Representation of Work and Change of State of the Refrigerant in All Parts of a Compression Machine (Bildliche Darstellung der Arbeitsvorgänge und Zustandsänderung des Kältemittels in allen Teilen der Kompressions-Kältemaschine). Gustav Döderlein. Action of such machines shown and discussed by indicator diagrams. Diagrams. 1700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 16, 1907. No. 82933 D.

Ventilation.

A Notable Jersey Schoolhouse Ventilating Plant. The heating and ventilating system installed in the Ashland School, in East Orange, N. J., is illustrated and described. Indirect heating from Kinnear radiation and from steam boiler setting. Ventilated by gravity or by fans. 2500 w. Met Work—March 2, 1907. No. 82676.

Ventilation of Office Buildings (Uber Lüftungseinrichtungen in Amtsgebäuben). Leopold Nowotny. Consideration of the size of air openings required. Diagram. 1800 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Jan. 26, 1907. No. 82934 D.

The Ventilation of the House of Commons. Walter Yates. Slightly abridged paper read before the Heat. & Vent. Engrs. of Gt. Britain. Plans and description of methods now employed, with brief account of earlier methods. 3500 w. Met Work—March 30, 1907. Serial. 1st part. No. 83318.

HYDRAULICS.

Energy.

The Kinetic Energy of Flowing Water. L. F. Harza. A mathematical investigation made to determine about what degree of dependence can be placed on the value of the energy as usually determined, and whether more accurate methods are worth while. 600 w. Eng News—March 7, 1907. No. 82800.

Pumps.

Centrifugal Pumps. Henry F. Schmidt. Remarks on recent improvements in these pumps, with reasons why the writer thinks they will soon replace the plunger pump where the volume of water to be handled is large enough so that a high efficiency can be obtained. Ills. 2000 w. Power—March, 1907. No. 82659 C.

Practical Efficiency of Centrifugal Pumps (Wirkungsgrade von Zentrifugalpumpen). E. Kux. Discussion of the question on the basis of actual tests. Diagrams. Serial. 2 parts. 2100 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 28, and March 9, 1907. No. 82946 each D.

Electric Pumps. D. Penman. Describes the high-speed turbine pump, and the electric three-throw pump. 1200 w. Min Rept—Feb. 28, 1907. No. 82749.

The Hydraulic Ram (Der hydraulische Widder). ——— Zink. Description of leading European types, and calculations of the effects produced. Ills. 4400 w. Oest Wochenschrift f d Oeffentlichen Baudienst—Feb. 2, 1907. No. 82931 D.

Stream Lines.

Stream Lines and Their Application to Engineering Purposes. Dr. H. S. Hele-Shaw. Abstract of a paper read before the Jr. Inst. of Engrs. Explains the method of investigation and gives practical examples of its application to engineering problems. 2800 w. Mech Engr—March 2, 1907. No. 82890 A.

Turbines.

New Theory of Turbines (Zur neuen Theorie der Kreiselräder). H. Lorenz. Mathematical treatment; one diagram. 4800 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 9, 1907. No. 82942 D.

Remarks Upon the Practical Application of Lorenz' Theory and Discussion of the Water Flow in Centrifugal Pumps (Bemerkungen über die praktische Verwendbarkeit der Lorenzschen Turbinentheorie und Vorschläge zur Klarstellung der Wasserbewegung in Kreiselrädern). Viktor Kaplan. Diagram. 1800 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 20, 1907. No. 82944 D.

Reply to Dr. Lorenz' Essay on a New Theory of Turbines (Erwiderung auf die Abhandlung von Prof. Dr. Lorenz, etc.). F. Prasil. Mathematical treatment and discussion of article 82942. 3200 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 20, 1907. No. 82943 D.

New Theory of Turbines: Part II. Answers to Kaplan's and Prasil's Criticisms (Zur neuen Theorie der Kreiselräder II. Autwort auf die Einwürfe der Herren Kaplan und Prasil). H. Lorenz. Replies to objections to the Lorenz theory. Diagrams. 4400 w. Zeitschrift für das Gesamte Turbinenwesen—Feb. 28, 1907. No. 82945 D.

Exposition of the Advantages of Tur-

bines and Centrifugal Pumps (Eine Veranschaulichung der Vorgänge in den Turbinen und Kreisel pumpen). Egon Eickhoff. Ills. 1600 w. Conclusion of serial. Zeitschrift für das Gesamte Turbinenwesen—Jan. 30, 1907. No. 82941 D.

MACHINE WORKS AND FOUNDRIES.

Boilers.

Calculating Butt-Strapped Boiler Seams. J. E. Werman. Explains a shortened method of determining relative superiority of inner and outer sections. Ills. 900 w. Power—March, 1907. No. 82653 C.

Calipering.

Calipers and the Art of Calipering. Frank A. Stanley. A collection of selected articles dealing with various phases of this subject, with many illustrations. 28500 w. Am Mach—Vol. 30, No. 10. No. 82794.

Castings.

The Characteristics of Foundry Iron. George Hailstone. Gives a résumé of its micro-constituents, discussing the results of mixtures of different grades and the causes of defective castings. Ills. 4500 w. Foundry—March, 1907. No. 83179.

Overcoming Difficulties in Casting Manganese Bronze. A. B. Brown. An illustrated account of the writer's experience, and final success. 3000 w. Brass Wld—March, 1907. No. 83281.

Molding a Large Jig Casting. Jabez Nall. Illustrates and describes the method of molding entirely in cores. 1000 w. Am Mach—Vol. 30, No. 12. No. 83145.

A Peculiar Chilled Casting. George C. Davis. Describes a casting presenting unusual features. 1000 w. Foundry—March, 1907. No. 83178.

Cores.

Time Lost in the Core Room. Jabez Nall. Discusses the making of a corebox for a four-step cone pulley, and other cores. Ills. 1600 w. Foundry—March, 1907. No. 83181.

Improved Method of Turning Valve Cores. James R. Kelly. Describes a method of arrangement which enables ten or twelve valves to be molded in the same size flask previously filled by four to six. Ills. 500 w. Foundry—March, 1907. No. 83177.

Cupola.

Construction and Management of the Cupola Furnace (Bau and Betrieb der Kupolöfen). C. H. Jaeger. Enumeration of the leading factors controlling the design of such furnaces. 2200 w. Stahl und Eisen—March 6, 1907. No. 82949 D.

Cutting Metals.

The Art of Cutting Metals. Discussion of the paper on this subject by F. W. Taylor. 10,000 w. Pro Am Soc of Mech Engrs—March, 1907. No. 83167 C.

Dies.

A Built-up Blanking Die That Will Keep Its Size. Julius F. A. Vogt. Sketch, with description of how they were made. 600 w. Am Mach—Vol. 30, No. 12. No. 83143.

Roughing and Finishing Spring Screw Dies. Erik Oberg. Gives method of calculating the amount of material to be removed, and the diameter of the roughing die. 800 w. Mach, N Y—March, 1907. No. 82769 C.

The Construction of Split Dies for Press Work. C. F. Emerson. Illustrates and describes methods. 1000 w. Mach, N Y—March, 1907. No. 82770 C.

Drilling.

The Work of Machine Tools (Expèriences sur le Travail des Machines-Outils). C. Codron. Results of experiments on the power required for drilling various metals and alloys. Ills. 8500 w. Rev de Mécan—Feb. 28, 1907. No. 82972 E + F.

Flywheels.

A High Efficiency Fly-Wheel Joint. Illustrates and describes Haight's fly-wheel joint, giving the highest commendation of the construction. 1400 w. Am Mach—Vol. 30, No. 9. No. 82665.

Foundry.

A Modern Grey Iron Foundry. Illustrated description of plant at Barberton, O., calling attention to novel features, and a few unique molding methods. 2200 w. Foundry—March, 1907. No. 83175.

Gears.

Gear Ratios for Motor Drives. W. Owen. Gives a table of gear changes for motor drives, explaining its use. 600 w. Am Mach—Vol. 30, No. 13. No. 83305.

Gearing.

The Mechanism of Power Transmission from Electric Motors. Wilfred L. Spence. Presents possible alternatives to the commoner methods, showing illustrations of good and bad practice, and also typical applications of each system. 9000 w. Trans Inst of Engrs & Shipbldrs in Scotland—Feb. 19, 1907. No. 83300 N.

Hammer.

108-Ton Pneumatic Hammer. A brief account of the Terni Steel Works, in Italy, with an illustrated description of this hammer and its operation. 1500 w. Engr, Lond—March 8, 1907. No. 83123 A.

Hardening.

Use of the Lead Pot in Hardening—Cyanide Solution. E. R. Markham. Suggestions of value in heating steel for hardening, and the treatment to secure good results. 1000 w. Am Mach—Vol. 30, No. 9. No. 82666.

Lathe.

A New Pratt & Whitney Lathe. Illus-

trated description of this new 16-in. engine lathe recently brought out. It is intended for tool-room use and for high-class manufacturing. 2500 w. Ir Age—Feb. 28, 1907. No. 82650.

Purchasing a Lathe. W. T. Sears. The importance of knowing what work the lathe is to do, the treatment it is likely to receive, etc. 1400 w. Am Mach—Vol. 30, No. 13. No. 83304.

Machine Foundations.

A Modern Foundation for Heavy Tools. Illustrated description of the system of putting in foundations for heavy tools, used by Norton Grinding Co., of Worcester, Mass. 700 w. Am Mach—Vol. 30, No. 10. No. 82793.

Machine Tools.

Machine Tools at the Nuremberg Exposition (Die Werkzeugmaschinen auf der Bayerischen Jubiläums-Landesausstellung, Nürnberg, 1906). G. Schlesinger. Description of shop tools, belt and motor driven, shown at Nuremberg. Ills. 1400 w. Continuation of serial. Zeitschr d Ver Deutscher Ing—Feb. 2, 1907. No. 82918 D.

Machining.

Machining Time-recorder Frames. Edward Snyder. Illustrating and describing the profiling and milling fixtures used and details of setting, supporting and clamping the work. 1500 w. Am Mach—Vol. 30, No. 12. No. 83146.

Molding Machines.

Modern Equipment in Old Plants. H. M. Lane. An illustrated account of molding machine development in a foundry at Cuyahoga Falls, Ohio. 2800 w. Ir Age—March 14, 1907. No. 83010.

Patterns.

Segment Works. H. N. Tuttle. Discusses a few schemes which are often used. Diagrams. 4300 w. Foundry—March, 1907. No. 83180.

Shops.

The New Locomotive Erecting Shop at Darlington Works, North-Eastern Ry. Charles S. Lake. Illustrated detailed description. 1400 w. Eng Rec—March 23, 1907. No. 83221.

The Works of the Union Twist Drill Company. Illustrated description of a plant equipped for the manufacture of gear cutters, milling cutters, etc., with facilities for machining, hardening and testing. 4000 w. Am Mach—Vol. 30, No. 10. No. 82791.

The Armstrong Pozzuoli Works. Illustrates and describes these important works, near Naples, Italy, for the manufacture of war material of all kinds. Plate. 1200 w. Engr, Lond—March 15, 1907. No. 83271 A.

Signals.

Factory Intercommunication Systems. John Drummond. An explanation of the electric light signals as used by the Cleveland Twist Drill Company. 2500 w. Ir Age—March 7, 1907. No. 82790.

Slide Valve.

Study of the D Slide Valve. E. S. Hawkins. A study of the practical working of the Zeuner diagram, giving examples with solutions. 3000 w. Power—March, 1907. No. 82657 C.

Soldering.

The Autogenous Soldering of Metals. M. U. Schoop. An illustrated article on the processes for carrying out autogenous soldering, and its wide utilization. 2500 w. Sci Am—March 2, 1907. No. 82642.

Tools.

The Making of High-Speed Steel Tools. O. M. Becker. Describes how these tools should be heated for forging and tempering and the apparatus advisable to use. Ills. 4500 w. Am Mach—Vol. 30, No. 12. No. 83144.

Helpful Hints for the Toolmaker. F. E. Shailor. Hints on cutting a smooth thread, hardening, cutting cams accurately, dies, etc. Ills. 1500 w. Mach, N Y—March, 1907. No. 82768 C.

A Useful Combination Tool. A. Frederick Collins. Illustrates and describes a tool combining on a single base, a pipe vise, an anvil, a forge, bench vise, drill press and emery wheel. 800 w. Sci Am—March 2, 1907. No. 82641.

Special Tools for Musical Instrument Work. S. J. Putnam. Illustrates and describes special tools and their making and use. 2000 w. Mach, N Y—March, 1907. No. 82767 C.

Vibrations.

Mill Vibrations. Eugene B. Whipple. Describes the nature and cause of some of these vibrations, and presents methods that have been employed in stopping them. 1500 w. Jour Worcester Poly Inst—March, 1907. Serial. 1st part. No. 83278 C.

Welding.

Methods and Costs of Electrically Welding 3,087 Girder Rail Joints at Camden, N. J. P. Ney Wilson. A report of the organization and cost of this work. 3000 w. Engng-Con—March 20, 1907. No. 83126.

Autogenous Welding With the Oxy-Acetylene High-Pressure Blowpipe. Illustrates and describes this system, which has recently been perfected by a London company. 1000 w. Sci Am—March 23, 1907. No. 83153.

Wire.

History of Wire Drawing (Geschichtliches von der Drahtzieherei). B. Neumann. 1600 w. Stahl und Eisen—Feb. 20, 1907. No. 82954 D.

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MATERIALS OF CONSTRUCTION.

Alloys.

Note on Alloys of Aluminum (Contribution à l'Etude des Alliages de l'Aluminium). Hector Pécheux. Results of investigations on the physical, electrical and chemical properties of aluminium and the more fusible metals, lead, tin, zinc, bismuth, etc. 4700 w. Rev Gen des Sci—Feb. 15, 1907. No. 82994 D.

Disintegration of Aluminum Alloys. Erwin S. Sperry. Gives illustrated examples of disintegration of half and half alloys. 500 w. Brass Wld—March, 1907. No. 83285.

Alloys of Manganese and Copper (Alliages De Manganèse De Cuivre). S. Wologdine. Review of some of these alloys, fusing points, micro-photographs, etc. Ills. 4600 w. Revue de Métallurgie—Jan., 1907. No. 82909 E + F.

Alloy Steel.

A Crucial Test of Modern Alloy Steel. Thomas J. Fay. An account of the condition of material, after a serious automobile accident while the car was traveling a mile a minute. Ills. 1800 w. Automobile—Feb. 28, 1907. No. 82668.

Nickel-Silicon Steels (Aciers Nickel-Silicium). M. L. Guillet. Study of the properties of steel with different proportions of nickel and silicon. Ills. 6500 w. Bull de la Soc D'Encouragement Pour L'Ind Nat—Original Memoirs—Dec., 1906. No. 82911 E + F.

Chrome Tungsten Steel (Aciers Chrome-Tungstène). M. L. Guillet. A study of steels by their microstructure. Ills. 6000 w. Revue De Métallurgie—Jan., 1907. No. 82908 E + F.

Nuts.

Note on the Working Loose of Nuts. André Minne. Discusses the ordinary lock-nut and describes an improved lock-nut. 1200 w. Bul Int Ry Cong—Feb., 1907. No. 83291 E.

Rails.

Open Hearth Steel Rails. Benjamin Talbot. Discusses the reasons for their displacement of the Bessemer product. 3300 w. Ir Age—Feb. 28, 1907. No. 82651.

Steels.

Steels Used on Automobile Construction. E. F. Lake. Gives analyses and physical characteristics of carbon chrome nickel steels and other high-class materials used in making frames, gears, etc. Ills. 5500 w. Am Mach—Vol. 30, No. 11. No. 83013.

MEASUREMENT.

Dynamometers.

On Some Forms of Rotative Output Dynamometers. W. W. F. Pullen. The present article deals with the absorption, or output dynamometers, the difficulties of their operation and the methods of surmounting them. Ills. 2800 w. Mech Engr—Feb. 23, 1907. Serial. 1st part. No. 82825 A.

Indicator Cards.

Reading Two-Stage Air-Compressor-Indicator Cards. Frank Richards. An explanation, with cards from a compressor tested. 1600 w. Power—April, 1907. No. 83242 C.

Metric System.

Our Present Weights and Measures and the Metric System. Discussion of paper by Henry R. Tame on this subject. 5800 w. Pro Am Soc of Mech Engrs—March, 1907. No. 83168 C.

POWER AND TRANSMISSION.

Air Compressors.

Some Important Elements of Economy in the Straight Line and Duplex Types of Compound Air Compressors. Lucius I. Wightman. Explains the advantages of compounding the relation of power to resistance in each type, losses, etc. Ills. 2000 w. Compressed Air—March, 1907. Serial. 1st part. No. 83301.

Sectionalized Air Compressors. Frank Richards. An illustrated article discussing sectionalized machines, their advantages and disadvantages. 1000 w. Am Mach—Vol. 30, No. 10. No. 82792.

The Flickinger Gas Driven Air Compressor. Illustrated detailed description of a combination of a gas engine and air compressor. 1200 w. Ir Age—March 7, 1907. No. 82789.

A Hydraulic Air-Compressing Plant. Illustrated description of the plant at the Victoria mine in the northern part of Michigan. A column of water sucks down the air which is trapped in a chamber and used for driving pneumatic machinery. 1200 w. Sci Am—March 16, 1907. No. 83018.

Some Features of Air Compression. C. A. Dawley. Reviews the development of air compressors, discussing the factors affecting the economy, the losses, and related subjects. 1100 w. Sib Jour of Engng—March, 1907. No. 83287 C.

Cranes.

150-Ton Hydraulic Wharf-Crane at Elswick. Illustrations, with brief description of a crane for putting heavy loads on board ships. 300 w. Engng—Feb. 22, 1907. No. 82836 A.

Electric Drive.

Advantages and Applications of the Electric Drive. F. B. Crocker and M. Arendt. Portion of lecture notes from the Electrical Engineering Department of Columbia University, with illustrations of various applications. 1600 w. Sci Am Sup—March 2, 1907. No. 82647.

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Elevators.

Electrically-Driven Hydraulic Lifts. Illustrated description of the Boddam system of combining the electrical drive with an existing hydraulic lift. 1200 w. Elec Engr, Lond — March 15, 1907. No. 83263 A.

High-Pressure Elevator Equipment of the Metropolitan Life Insurance Building, New York. Illustrated detailed description of the elevator plant for an unusually large building and extensive elevator service. 3500 w. Eng Rec—March 23, 1907. No. 83212.

Fuel Handling.

Coal Storage and Coal Conveying Systems. Franz Koester. Illustrates and describes some of the modern methods employed in handling fuel for large power stations at home and abroad. 3800 w. Power—April, 1907. No. 83244 C.

Gear Wheels.

Loss of Power by Transmission with Geared Wheels. John Batey. A study of the frictional resistance of toothed gear drives. 2300 w. Prac Engr—March 1, 1907. No. 82884 A.

Power Plants.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Shon. Gives a comparison of availibility, efficiency and cost, and reviews the development of water power into electric energy. 5500 w. Engineering Magazine—April, 1907. No. 83312 B.

Power Plant of the Quintard Iron Works Company of New York City. Illustrated detailed description of the power plant for shops manufacturing heavy and light machine work, engines, boilers, large condensers, pumps, etc., etc. Electric power, steam and compressed air are used. 5000 w. Elec Rec, N Y—March 16, 1907. No. 83064.

Ravenna Plant of the Cleveland Mills Co. Illustrated description of a plant that supplies electric power for lighting and for driving machinery, and steam for various uses connected with the manufacture of worsteds. 2500 w. Engr, U S A—March 1, 1907. No. 82741 C.

Power Plants for Private Commercial Establishments (Grossstädtische Kraftwerke für Privatbetriebe). E. Josse. Description of some large independent plants for factories in Germany. Ills. Serial. 3 parts. 11000 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 16 and 23, and March 2, 1907. No. 82928 each D

Ropes.

The Splicing of Fibrous Ropes. V. C. Vance. Instructions, with illustrations. 1200 w. Engr, U S A—March 15, 1907. No 83093 C.

Shaft Hangers.

Attaching Fixtures to Concrete. L. P. Alford. Illustrates and describes devices worked out for a plant at Beverly, Mass. 1800 w. Am Mach—Vol. 30, No. 11. No. 83012.

Storage Batteries.

Hints on the Practical Management of the Storage Battery—Precautions Necessary in Charging and Discharging End Cells. William Kavanagh. Information, with illustrations. 1400 w. Power—March, 1907. No. 82658 C.

Storage Battery Economy in Railway Power Plants. Arthur C. Scott. Discusses the conditions warranting the installation of a battery. Ills. 1800 w. Engr, U S A—March 1, 1907. No. 82742 C.

STEAM ENGINEERING.

Boilers.

Effect of Water on the Life of Boilers. A. S. Atkinson. Discusses the effect of feed-water, loss of efficiency due to scale, the effect of sulphuric acid and acid iron salts, and methods of removing dangerous elements from the feed water before it enters the boiler. 2200 w. Boiler Maker—March, 1907. No. 82677.

Watching a Boiler at Work—An Account of Experiments with a Glass Model of a Water-tube Boiler. C. Hill Smith. Ill. 2300 w. Power—April, 1907. No. 83246 C.

Clearance.

The Compression of Steam in the Clearance Space of Engines (Expériences sur la Compression de la Vapeur dans l'Espace Nuisible des Machines à Vapeur). J. Boulvin. Gives the results of elaborate experiments on a single-cylinder, non-condensing engine using saturated steam. Ills. 10000 w. Rev de Mécan—Feb. 28, 1907. No. 82973 E + F.

Condensers.

Condensers and Condensing Plants. Illustrates and describes types of jet condensers and of surface condensing plants. 2200 w. Mech Engr—March 9, 1907. Serial. 1st part. No. 83106 A.

Engines.

The Proper Management of Corliss Engines. W. H. Wakeman. An illustrated article treating especially of the adjustment of the valve gear and how to avoid mistakes often made by engineers. 2200 w. Power—April, 1907. No. 83241 C.

Shop Talk About Steam Engines. C. W. Crawford. A comparison of the clearance and leakage losses in the various types of poppet valve, slide valve, and Corliss engines. 2500 w. Am Mach—Vol. 30, No. 13. No. 83306.

Trials of Engineers in the Early Days. Alonzo G. Collins. Gives results of research in England for engine types of the time of Newcomen and Watt. Ills. 3000

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w. Power—April, 1907. Serial. 1st part. No. 83243 C.

Types of Early Steam Engines Still Working in England. Information relating to a few plants installed over one hundred years ago, and still working. 1600 w. Sci Am Sup—March 2, 1907. No. 82649.

Firing.

Instructions to Govern the Use of Coke on Locomotives. Instructions issued by J. E. Muhlfeld, of the B. & O. R. R. to govern the use of coke on the locomotives of that road. 1200 w. Am Eng & R R Jour—March, 1907. No. 82781 C.

Fuels.

Fuels for Steam Making. R. T. Strohm. Considers the heat-producing elements in fuels, the constituents, the requirements of good steam producing fuels, and related matters. 2500 w. Elec Wld—March 2, 1907. No. 82777.

Governors.

Shaft Governors. C. F. Swingle. General remarks, with descriptions of Poncelot's governor, Siemens' governor, and the Fitchburg shaft governor. Ills. 2200 w. Engr, U S A—March 1, 1907. No. 82743 C.

Mechanical Draft.

The Application of Mechanical Draft to Stationary Boilers. Walter B. Snow. Presents the advantages of mechanical draft, and discusses the cost. 3500 w. Cal Jour of Tech—March, 1907. No. 83190.

Oil Fuel.

Commercial Aspects of Oil as Fuel for Power Generation. Franz Erich Junge. Considered in competition with other combustibles used in the generation of power, with remarks on its value and quantity of production and general characteristics. 4000 w. Power — March, 1907. No. 82654 C.

Regulators.

The Regulation of Boiler Feeders. Charles S. Towne. Illustrates several applications of regulators to boilers, and discusses when it will pay to install them. 2000 w. Elec Wld—March 2, 1907. Serial. 1st part. No. 82778.

Superheating.

The Specific Heat of Superheated Steam. Discusses results of recent experiments. 1500 w. Engng—Feb. 22, 1907. No. 82832 A.

Present Practice in the Use of Superheated Steam. Reginald Pelham Bolton. Discusses American practice and applications, the advantages, limitations, etc. 3000 w. Engineering Magazine — April, 1907. No. 83316 B.

Thermodynamics.

The Dynamics of Steam in Piston Engines (Zur Dynamik der Dampfströmung in der Kolbendampfmaschine). W. Schüle and Otto Schneider. Mathematical treatment. Diagrams. 2200 w. Zeitschrift des Vereins Deutscher Ingenieure—Feb. 9, 1907. No. 82924 D.

Turbines.

Notes on Turbine Troubles. G. Nevil-Thomas. Calls attention to some troubles met with in the writer's experience. 1000 w. Elec Rev, Lond—Feb. 22, 1907. No. 82827 A.

The Kerr Steam Turbine. C. V. Kerr. Illustrated description of a turbine built on the principle of the Pelton water wheel. It is a nozzle and bucket turbine of the impulse type. 3000 w. Power—March, 1907. No. 82655 C.

Steam Turbines and Their Use in Electric Railway Power Plants (Die Dampfturbinen und ihre Anwendung auf den elektrischen Bahnbetrieb). Guido Semenza. Comparison between the leading types and examples of their use in Europe. 5900 w. Serial. 3 parts. Zeitschrift für das Gesamte Turbinwesen—Jan. 30, Feb. 9 and Feb. 20, 1907. No. 82940 each D.

Valve Gear.

Adjusting Stephenson Valve Gear. James Kennedy. Detailed directions for the adjustment with related information. Ills. 2500 w. Ry & Loc Engng—March, 1907. No. 82700 C.

Single-Eccentric Meyer Valve Gear. H. V. Haight. Drawings and description of a valve gear in which both main and cut-off valves are driven from a single eccentric. 500 w. Am Mach—Vol. 30, No. 9. No. 82667.

Water Softening.

The Present Status of the Art of Water Softening. Explains why hard water is unsatisfactory in the industries, and the principles of water softening and its practice, illustrating many plants. 4800 w. Cassier's Mag—March, 1907. No. 83030 B.

Water-Tubes.

Tempersley-Cockburn System of Steam Extraction for Water-Tube Boilers. Illustrated description, with report of trials made with boilers of the Belleville type. 2500 w. Mech Engr—March 2, 1907. No. 82888 A.

MISCELLANY.

Aeronautics.

An Interesting German Flying Machine. Dr. Alfred Gradenwitz. The machine developed by J. Hofman, of Berlin, is illustrated and described. 1500 w. Sci Am—March 23, 1907. No. 83152.

New French Aeroplanes. Illustrates and describes Santos Dumont's new aeroplane, and M. Delagrange's aeroplane. 1500 w. Sci Am—March 30, 1907. No. 83297.

Metal Evaporation.

The Evaporation of Solid Metals and Their Compounds. Describes method of demonstrating. 1000 w. Sci Am—Apr. 6, 1907. No. 83455.

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MINING AND METALLURGY

COAL AND COKE.

Accidents.

Falls of Roof and Coal. Recommendations of the Prussian Commission with a view to prevent accidents. 1200 w. Min Wld—March 2, 1907. No. 82757.

Coal-Cutting.

Electrical Coal-Cutting by Bar Machines, with Special Reference to the "Simplex" Machine. Arthur Hall. Read before the Nat. Assn. of Col. Mgrs. The discussion is confined to bar machines, stating their advantages over disc machines, and illustrating and describing the Goolden machine and "Simplex" and the "Hurd." 8000 w. Ir & Coal Trds Rev—March 1, 1907. No. 83005 A.

Coal Dust.

The Coal Dust Problem. James Ashworth. Gives quotations from the report of W. N. Atkinson, Henry Hall, and Dr. J. S. Haldane on their recent visit to the Westphalian coalfield, with discussion of the question. 4500 w. Engr, Lond—March 15, 1907. No. 83270 A.

Coal Fields.

The Hidden Coal Fields of the Midlands. Prof. C. Lapworth. Abstract of a paper before the S. Staffordshire & Warwickshire Inst. of Min. Engrs. Describes the geology of this region, and gives the conclusions from facts based on research, discussing the prospect of production from the commercial point of view. 4000 w. Min Jour—Feb. 23, 1907. No. 82830 A.

The Discovery of the South-Eastern Coal Field. Prof. W. Boyd Dawkins. An account of the discovery of this new coalfield in England, tracing the gradual verification of Godwin-Austen's theory by a series of experiments, and furnishing a striking instance of the value of scientific research. General discussion. Ill. 6500 w. Jour Soc of Arts—March 8, 1907. No. 83095 A.

Coke.

Manufacture of Coke from Western Coal. R. S. Moss. Shows the difference between eastern and western coals, and claims that coke can be made from western coals if work is carried out on established principles. 1200 w. Min Wld—March 16, 1907. No. 83088.

Coke Supply.

The Connellsville Coke Supply. L. W. Fogg. Deals with the coal areas and coke supply of Fayette and Westmoreland counties, Pennsylvania. 1200 w. Ir Age—March 28, 1907. No. 83294.

Electricity.

Use of Electricity in Anthracite Mining. H. M. Warren. Illustrates and describes the equipment of the Woodward mines at Kingston, Penn., an example of an isolated direct-current station. 800 w. Eng & Min Jour—March 2, 1907. No. 82692.

Electrically Driven Colliery Pumps. Alfred Gradenwitz. Illustrated description of the electric pumping installation at the Concorde collieries, Belgium. 1200 w. Eng & Min Jour—March 9, 1907. No. 82819.

Gases.

Coal Mine Gases and Barometric Pressure. Floyd W. Parsons. Observations on the possibility of concurrent action on the part of mine gases and fluctuations in atmospheric pressure. 1800 w. Eng & Min Jour—March 2, 1907. No. 82691.

Haulage.

Electric Power vs. Mules for Mine Haulage. M. B. Peltier. Illustrated description of the electric installation at the No. 3 mine of the Peabody Coal Co. in Illinois. Shows an increase in output, and effects a saving of one cent per ton. 1200 w. Eng & Min Jour—March 16, 1907. No. 83078.

Indiana.

Method of Mining in Indiana Coal Fields. Floyd W. Parsons. Illustrated description. Suggests a plan for preventing squeezes due to hard roof and soft bottom. 2000 w. Eng & Min Jour—March 23, 1907. No. 83224.

Outputs.

Large Coal Mine Uutputs. F. C. Keighley. A paper read before the Coal Mining Inst. of America. Discusses whether it pays to design and develop coal mines for very large outputs, and some of the causes that fix the limits. 3000 w. Mines & Min —March, 1907. No. 82760 C.

Peat.

The Technology and Uses of Peat. C. W. Parmelee. Abstracted from the annual report of the State Geologist of New Jersey. The present number considers peat as a fuel, giving information in regard to its heating power. 1500 w. Sci Am Sup—March 2, 1907. Serial. 1st part. No. 82810.

Pillars.

Removing Pillars in Coal Mines. William Hardy. Abstract of a paper read before the Coal Min. Inst. of America. Treats of the removal of pillars underlying surface waters, and the successful filling of worked out areas, cribbing, and

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the management of water. 2500 w. Min Wld—March 9, 1907. No. 82856.

Wyoming.

Coal in Wyoming. Information of this important mineral product, production, development, etc. 1500 w. Min Rept—March 21, 1907. No. 83230.

COPPER.

Air Compressor.

A Taylor System Air Compressor at the Victoria Copper Mine, Michigan. A. H. Rose. Illustrated description of a large air compressor built on lines developed from a water trompe of large size and giving economical results. 2500 w. Mines & Min—March, 1907. No. 82759 C.

California.

Trinity Copper Mine in California. Kirby Thomas. Map and detailed description of this property and account of its development. 3300 w. Min Wld—March 2, 1907. No. 82756.

Converter.

A Modern Electric Converter. G. B. Shipley. Describes the converter plant for the Orford Copper Co., at Constable, N. J. It consists of three electrically operated stands and nine shells. 2200 w. Min Wld—March 23, 1907. No. 83229.

Deep Mining.

Deep Mining in the Lake Superior Region. F. W. McNair. Abstract of address before the Am. Assn. for the Adv. of Sci. Illustrates and describes methods used at depths of about 5,000 ft. in the copper mines of this region. 3000 w. Min & Sci Pr—March 2, 1907. No. 82850.

Deposits.

Copper Deposits of Washington, U. S. A. Hon. Albert W. McIntyre. An interesting account of these deposits, explaining why their development has been slow, and giving much information in regard to the deposits in this state. 6000 w. B C Min Rec—Jan., 1907. No. 82848 B.

Nevada.

The Low-Grade Copper Deposits at Ely, Nevada. William Starr Bullock. Illustrated description of the extensive deposits and the proposed methods of working. 2200 w. Eng & Min Jour—March 16, 1907. No. 83073.

Ore-Bins.

Steel Ore-Bin Construction. W. R. Crane. Notes and sketches descriptive of the ore-bins at Shaft No. 3, of the Wolverine mine in the Lake Superior region. 2000 w. Min & Sci Pr—March 9, 1907. No. 83052.

Queensland.

The O. K. Copper Mine, North Queensland. R. Logan Jack. Report of a recent inspection of this field. 5500 w. Queens Gov Min Jour—Jan. 15, 1907. No. 82821 B.

Siberia.

Mining and Smelting in Southern Siberia. H. E. West. An illustrated account of properties examined, the nature of the deposits of copper, and related matters. 2000 w. Eng & Min Jour—March 9, 1907. No. 82817.

Wyoming.

Platinum-Copper Ores in Wyoming. Concerning the complex New Rambler ores and the concentration methods for an economical treatment. Ills. 1700 w. Min Rept—March 7, 1907. No. 82849.

GOLD AND SILVER.

Arizona.

The Vulture Mine, Arizona. C. W. Purington. An illustrated description of this mine and the deposits of gold in schist, with an account of the development. 2500 w. Min & Sci Pr—March 9, 1907. No. 83053.

Tombstone, Arizona, Restored. R. B. Brinsmade. An account of the rise and fall of this town, new developments at some of the old mines, yielding ore values in gold, silver and lead, application of the cyanide process, etc. Ills. 3800 w. Mines & Min—March, 1907. No. 82764 C.

Australia.

Metallurgy at Broken Hill, New South Wales. Ralph Stokes. An illustrated account of the treatment of these silver-lead ores, describing the new mill through which 6,000 tons of ore are passed per week. 3500 w. Min Wld—March 2, 1907. No. 82755.

Mining at Broken Hill, New South Wales. Ralph Stokes. An account of the methods of mining in this silver-lead district. 3500 w. Min Wld—March 9, 1907. No. 82854.

Concentration of Mixed Sulphides at Broken Hill (L'Enrichissement des Minerais Sulpurés Mixtes de Broken Hill). E. Lemiare. Description of the ores, the concentrating problem and the methods used to obtain a concentrate of the argentiferous galena. Ill. 5400 w. Génie Civil—Mar. 9, 1907. No. 82976 D.

Mining and Smelting at Mount Lyell. R. C. Sticht. From the annual report of the Zeehan School of Mines. Describes this mining district, the deposits, method of ore excavation, the values being in copper, gold and silver. 3500 w. Min Jour—March 2, 1907. Serial. 1st part. No. 82896 A.

British Columbia.

The Fraser as a Dredging Field. H. G. Stringer. An account of this river as a gold producer, and the attempts at dredging. Ills. 2200 w. Min Jour—March 16, 1907. No. 83269 A.

California.

The East Country of the Mother Lode.

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John A. Reid. Describes the interesting features of the Shady Run mine. The ore deposits are a quartzose pyritic gold, and an ore rather low in silica, heavy with arseno-pyrite, and containing free gold. 1400 w. Min & Sci Pr—March 2, 1907. No. 82851.

Cobalt.

Cobalt, Canada, the New Silver-Mining District. J. E. Hardman. An illustrated review of the discovery, history, development and peculiar characteristics of this silver-bearing region. 2500 w. Engineering Magazine—April, 1907. No. 83311 B.

Method of Smelting Cobalt Ores. Hiram W. Hixon. Describes a proposed system for smelting these ores in Canada, stating the advantages. 900 w. Eng & Min Jour—March 2, 1907. No. 82689.

Mines and Mining at Cobalt. Willet G. Miller. Information in regard to the geology, characteristics of the veins, origin of the ores, production, etc. 3000 w. Can Min Jour—March 15, 1907. No. 82857.

Colorado.

The Gold Prince Mine and Mill. George P. Scholl and R. L. Herrick. An illustrated description of methods of mining on the Sunnyside Lode, the concentrating mill, tube mills, and methods of extraction for low-grade ores. 6500 w. Mines & Min—March, 1907. No. 82758 C.

The Maple Leaf Mine, Colorado. Arthur Lakes. Illustrates and describes the peculiar geological formation of this gold-bearing region. 1000 w. Min Wld—March 9, 1907. No. 82855.

Dredging.

Recent Applications of Gold Dredging Machinery. Francis C. Nicholas. Illustrates and describes a special dredge designed to save both placer gold and diamonds. Suggests its application in other fields. 900 w. Min Wld—March 23, 1907. No. 83228.

French Guiana.

Placer Mining in French Guiana. Leon Delvaux. An illustrated account of old and new methods on the Elysee placer, and the success. 2000 w. Eng & Min Jour—March 2, 1907. No. 82688.

Ketchikan.

The Ketchikan Mining District in Southeastern Alaska. An illustrated article giving particulars of the mines and smelters. 9000 w. B C Min Rec—Jan., 1907. No. 82847 B.

Klondike.

Placer Mining in the Klondike. Joseph B. Tyrrell. An illustrated account of the conditions prevailing in the district, and the interesting new methods developed. Extracted from a paper before the Inst. of Min. Engrs., London. 4000 w. Eng & Min Jour—March 2, 1907. No. 82686.

The Year 1906 in the Klondike District. J. P. Hutchins. A report of the year showing changes in plan of working, and discussing some of the problems of this region. 2500 w. Eng & Min Jour—March 16, 1907. No. 83076.

Nevada.

The Old Camps of Ward, Nevada. H. R. Plate. A brief historical review of the Martin White mine, a silver-lead producer of the '70s, and early '80s, which is to be worked for copper and lead. 1000 w. Min & Sci Pr—March 2, 1907. No. 82852.

Placers.

Conserving the Water Supply in Placer Mining. Dennis H. Stovall. Considers advantages gained by properly constructed reservoirs, to lengthen the hydraulic season, and the employment of a self-shooter. 1000 w. Ores & Metals—March 20, 1907. No. 83232.

Loss of Gold in Placer Mining. Dennis H. Stovall. Suggestions for a durable and efficient riffle, and remarks on causes of loss. 1000 w. Min & Sci Pr—Feb. 23, 1907. No. 82751.

Pockets.

Pockets in the Upper Portions of Gold Veins. George W. Kimble. Sketch and description of some of the pockets found in Eldorado County, California. 1200 w. Min & Sci Pr—March 16, 1907. No. 83195.

Precipitation.

Electrolytic Precipitation of Cyanide Solutions. Charles P. Richmond. Illustrates and describes the process used at the San Sebastian mine, San Salvador, which yields fine gold and separates the copper in a marketable form. 2500 w. Eng & Min Jour—March 16, 1907. No. 83074.

Rand.

Rand Mining Conditions. E. M. Weston. Begins a discussion of the cause of shortage of labor and other existing conditions. 2000 w. Aust Min Stand—Feb. 6, 1907. Serial. 1st part. No. 83129 B.

Slimes.

The Homestake Slime Plant. Mark Ehle, Jr. Illustrates and describes the Merrill automatically discharged filter press, and the plant for treating slimes carrying gold values of 80 cents per ton. 4000 w. Mines & Min—March, 1907. No. 82762 C.

Smelting.

Silver-Lead Smelting Practice. T. S. Austin. Discusses slag composition and characteristics, and furnace operations. 1800 w. Min & Sci Pr—Feb. 23, 1907. No. 82752.

South Africa.

Conditions Met in South African Mining. J. H. Pitchford. From an address before the students of the Univ. of Cali-

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fornia. Shows that in spite of the high cost of supplies, transportation, and labor, the low-grade gold-deposits are made to yield enormous profits. 5000 w. Eng & Min Jour—March 9, 1907. No. 82816.

Mining in South Africa. J. B. Pitchford. A lecture delivered to the mining students of the University of California, giving an account of the gold discoveries of this region and their development. 2000 w. Min & Sci Pr—March 9, 1907. Serial. 1st part. No. 83054.

IRON AND STEEL.

Blast Furnaces.

Some Modifications in Blast Furnace Construction. Julian Kennedy. Explains improvements made in furnace construction, which give greater safety to employees. Discussion. Ills. 4000 w. Pro Engrs' Soc of W Penn—Feb., 1907. No. 83034 D.

Efficiency.

Thermal Efficiency of Open-Hearth Furnaces. Considers the total heat available for the purposes of the furnace, and the distribution. 4500 w. Elec-Chem & Met Ind—March, 1907. No. 82872 C.

Gas Currents.

Direct Measurement of the Speed of Hot Gas Currents (Direkte Messung der Geschwindigkeit heisser Gasströme). R. Vambera and F. Schraml. Description of a simple method and calculation of results. Diagrams. 2200 w. Stahl und Eisen—Mar. 6, 1907. No. 82948 D.

Germany.

Treatment of Iron Ore (Die Bewertung der Eisenerze). M. Drees. Outline of present day German methods. 2300 w. Stahl und Eisen—Mar. 6, 1907. No. 82955 D.

Low-Grade Ores.

Utilizing Impure Iron Ores. Illustrated description of the Gröndel briquetting process for low-grade ores. 1400 w. Min Wld—March 16, 1907. No. 83089.

Metallography.

Crystallization of Iron (Sur la Cristallisation du Fer). F. Osmond and G. Cartaud. Comprehensive study of the crystal forms under different conditions. Illus. 12700 w. Bulletin de la Société d'Encouragement pour l'Industrie Nationale—Original Memoirs—Dec. 1, 1906. No. 82910 E + F.

Nomenclature.

Iron and Steel Nomenclature. Gives the metallurgical definitions presented by the committee at the Brussels Congress of the International Association for Testing Materials, which are to be submitted to the Iron and Steel Inst., and other organizations for indorsement. 2000 w. Ir Age—March 28, 1907. No. 83293.

Ontario.

Iron Mining in Northern Ontario. A. B. Willmott. Brief illustrated description of the more important exploratory work of the past year. 1300 w. Can Min Jour—March 15, 1907. No. 82859.

Pig Iron.

The Economical Production of Pig Iron.—A Study of Conditions Existing in the Blast Furnace. Horace Allen. A theoretical and mathematical discussion of the factors necessary for maximum efficiency. 2300 w. Ir Trd Rev—March 14, 1907. No. 83007.

Siemens-Martin.

Contribution to the Metallurgy of the Siemens Martin Process (Beitrag zur Metallurgie des Martinprozesses). Theodor Naske. Comprehensive account of researches on this subject. Diagrams. Serial. 4 parts. 12000 w. Stahl und Eisen—Jan. 30, Feb. 6, Feb. 13, and Feb. 20, 1907. No. 82951 each D.

Steel Works.

Imperial Japanese Government Steel Works at Wakamatsu. From a report by H. M. Charge d'Affaires at Tokio to the Board of Trade. Descriptive account. 2500 w. Ir & Coal Trds Rev—March 8, 1907. No. 83125 A.

Use of Electric Power in Ironworks (Die elektrische Kraftübertragung in Hüttenwerken). F. Janssen. Comprehensive account of European practice in use of electric driving. 7000 w. Stahl und Eisen—Feb. 20, 1907. No. 82953 D.

First Electrical Reversing Apparatus Installed at the Hildegard Works, Austria (Der erste elektrische Reversierstrassenantrieb, ausgeführt auf der Hildegardehütte). D. Geyer. Illus. Serial. 2 parts. 4600 w. Stahl und Eisen—Jan. 23 and 30, 1907. No. 82947 each D.

Ironworks Machinery (Maschinelle Einrichtungen für das Eisenhüttenwesen). Fr. Frölich. Various heavy machines described. Continuation of serial. Illus. 1900 w. Zeitschrift des Vereines Deutscher Ingeniure—Feb. 9, 1907. No. 82926 D.

Tempering.

Heyn's Experiments on the Tempering and Annealing of Steel (Les Experiences du Prof. Heyn la Trempe et le Revenu des Aciers). M. F. Osmond. Diagrams and tables. 3500 w. Bull de la Soc d'Encouragement pour l'Industrie Nationale—Original Memoirs—Dec. 1, 1906. No. 82913 E + F.

Tin Plates.

Rolling of Sheet Steel for Tin Plates. A descriptive account of the rolling of sheet metal. 2000 w. Prac Engr—March 15, 1907. No. 83260 A.

MINING.

Accidents.

Accidents due to Electricity in Mines

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(Unfälle durch Elektrizität in Bergwerken). R. Rinkel. Enumeration and classification of casualties in European mines using electric power. 1200 w. Elektrotechnische Zeitschrift—Feb. 28, 1907. No. 82964 B.

Belt Elevators.

Belt Elevators for Ore and Water. Edward S. Wiard. Gives the writer's experience with these machines in wet concentrating mills, with advice as to methods of overcoming troubles. Ills. 4500 w. Eng & Min Jour—March 23, 1907. No. 83225.

Brazil.

The Mineral Industry of Brazil. Arrajado R. Lisboa. Information concerning the deposits and mining of gold, diamonds, manganese, iron, coal, copper, and monazitic sands. 2000 w. Eng & Min Jour—March 2, 1907. No. 82687.

Cave-in.

The Cave-in of an Inclined Shaft and Subsequent Rescue of an Entombed Miner, at Bakersfield, Cal. F. C. Finkle. Explains the nature of the work in hand and the plans for its construction, the accident and methods of rescue. Ills. 2000 w. Eng News—March 21, 1907. No. 83198.

Colorado.

A Trip to San Juan, Colorado. Prof. Arthur Lakes. Describes this region and some of the remarkable geological formations. 2000 w. Mines & Min—March, 1907. No. 82761 C.

Drilling.

A Miner's Drills and His Work with Them. Matt. W. Alderson. Points on the depth of holes drilled, their loading, etc. 900 w. Min & Sci Pr—March 2, 1907. No. 82853.

Drills.

History and Present Status of Air Hammer Drill. H. L. Sinclair. An account of the development of this tool for mining purposes, and a statement of its advantages. 3800 w. Ores & Metals—March 5, 1907. No. 82845.

Dynamite.

How the Miner's Dynamite is Made. Whitman Symmes. An explanation of the nitro-glycerine processes and the products used in its manufacture. 4000 w. Min & Sci Pr—March 9, 1907. Serial. 1st part. No. 83055.

Electric Winding.

Some New Flywheel Storage Systems. A. P. Wood. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Describes some three-phase and some continuous current systems, giving diagrams. 4000 w. Ir & Coal Trds Rev—Feb. 22, 1907. No. 82843 A.

Grab System.

Grab System of Mining at the Grant Mine, Buhl, Minn. Description of the grab system of stripping and mining as installed at this mine. 3000 w. Ir Trd Rev—March 14, 1907. No. 83008.

Labor.

Notes on Mexican Mine Labor. Carl A. Allen. An explanation of the systems of employing the Mexican, showing that he can be worked in most cases to better advantage as a day's pay man, and giving a comparison of the Mexican and American miner. 2200 w. Min & Sci Pr—March 16, 1907. No. 83196.

New Zealand.

History of Hydraulic Mining in New Zealand. John Ewing. Outlines the work of nature in the South Island of New Zealand, and the early methods of extraction of gold, describing the system of hydraulic elevating introduced in 1878. 2700 w. Min Jour—March 9, 1907. No. 83-112 A.

Ore Reserves.

Notes on the Estimation and Valuation of Ore Reserves. W. R. Tait. A record of actual practice at the valuation of a mine on the Rand. 2300 w. Jour Chem, Met & Min Soc of S Africa—Jan., 1907. No. 83097 E.

Pumping Plant.

Discussion on Electrically-Driven Centrifugal Pumping Plant at the Tywarwhaile Mine. Discussion of W. R. Thomas' paper on this subject. 8000 w. Inst of Min & Met, Bul. 30—March 14, 1907. No. 83289 N.

Reduction.

Dry Air in Ore Reduction. Jos. H. Hart. Briefly explains the deterrent effects of moisture in the air in industrial applications, the existing methods of eliminating it, with their first costs and maintenance, and the increased economies that result. 1500 w. Min Wld—March 16, 1907. No. 83086.

Refrigeration.

The Adaptation of Refrigeration to Mining. Jos. H. Hart. Considers the application of mechanical refrigeration to cooling very deep mines, to stop water entering a mine, and to remove quicksand and mud, describing the compression and absorption systems. 2000 w. Min Wld—March 2, 1907. No. 82753.

Shaft-Sinking.

Shaft-Building by Raising. W. H. Storms. Illustrates and describes a practicable scheme for shaft-building by means of raising. 2000 w. Min & Sci Pr—Feb. 23, 1907. No. 82750.

Smelting.

The Location of Smelting Works. Herbert Lang. Advocates the one level plan, considering its advantages as compared with the terrace site. 3500 w. Eng & Min Jour—March 23, 1907. No. 83226.

We supply copies of these articles. See page 316.

The Smelter Smoke Problem. F. W. Traphagen. Read before the West. Assn. of Tech. Chem. & Met. Considers the possibility of damage to soil, to crops and to live stock, concluding that in some cases acid gases from smelter smoke may do damage, and recommending high stacks. 3000 w. Min Rept—March 14, 1907. No. 83085.

The Lead-Smelting Works of Port Pirie. Guillaume D. Delprat. Illustrates and describes smelting plant where the ores from Broken Hill are smelted and the bullion refined and prepared for market. 2500 w. Eng & Min Jour—March 16, 1907. No. 83075.

Ventilation.

Underground Fans as Main Ventilators. James Tonge. A reply to criticisms of an article on this subject. 2200 w. Mines & Min—March, 1907. No. 82763 C.

Winding.

Safety in Winding. George H. Winstanley. Read before the Nat. Assn. of Col. Mgrs. Classifies and discusses all the accidents possible. Also discussion. 9000 w. Ir & Coal Trds Rev—March 15, 1907. No. 83273 A.

MISCELLANY.

Bauxite.

The Bauxite Industry of the South. Edward K. Judd. Information in regard to the Georgia-Alabama district and its development. 2000 w. Eng & Min Jour—March 23, 1907. No. 83227.

Calcium.

Critical Discussion of the Electrolytic Method for the Production of Calcium (Kritische Betrachtungen über die Elektrolytische Gewinnung des Calciums). Carl Bürgel. Description of process. Illus. Serial. First and second instalments. 1300 w. Elektrotechnische Zeitschrift—Jan. and Feb., 1907. No. 82937 each G.

Chemistry.

Annual Review of Mineral Chemistry (Revue Annuelle de Chimie Minérale). A. Mailhe. A review of the progress of mineral chemistry in 1906, dealing with high temperatures, metalloids, metals and metallic salts. 5700 w. Rev Gen des Sci—Feb. 28, 1907. No. 82993 D.

Iceland.

Minerals of Iceland. L. P. Gratacap. Illustrates and describes some of the interesting minerals found. 2000 w. Min Wld—March 16, 1907. No. 83087.

Manganese.

The Crimora Manganese Mine. E. K. Judd. An account of the geology and methods of mining of this mine in Virginia. 1500 w. Eng & Min Jour—March 9, 1907. No. 82818.

Metallurgy.

Recent Developments in Metallurgy. S. F. Kirkpatrick. Gives examples showing the recent advances made. 2200 w. Can Min Jour—March 15, 1907. No. 82858.

New Zealand.

Prize Essay on the Mineral Resources of New Zealand. Robert McIntosh. A lengthy discussion of the present condition and future prospects of the mineral resources of New Zealand, and the best means of fostering their development. 56500 w. N Z Mines Rec—Jan. 16, 1907. No. 83208 B.

Phosphates.

Phosphate Mining in Tennessee. H. D. Ruhm. An illustrated review of development, and of the present situation and prospects. 3500 w. Eng & Min Jour—March 16, 1907. No. 83077.

Pyrometry.

See Electrical Engineering, Measurement.

Rare Minerals.

Rare Metals and Minerals and Their Uses. E. Schaaf-Regelman. Interesting information concerning the supply and demand of rare minerals, their use in high-speed tool-machines, tools, incandescent lighting, etc. 3500 w. Engineering Magazine—April, 1907. No. 83317 B.

Tin.

Revival of the Mining Industry in Cornwall. Edward Walker. An illustrated article explaining the geology and mineral deposits, and giving an account of modern methods which may restore abandoned properties to the list of producers. 4000 w. Eng & Min Jour—March 9, 1907. No. 82815.

Tin Smelting at Banka. J. Koomans. A short description of the smelting and refining. 1500 w. Min Jour—March 23, 1907. Serial. 1st part. No. 83421 A.

Zinc.

Design of a Zinc Smeltery. Reprint of Mr. Ingalls' views as given in the report of the British Columbia commission. Considers the technical and economical features of the plant. 3500 w. Ores & Metals—March 20, 1907. No. 83233.

The Zinc Industry in Colorado. The present article is a review of the history and production. 1000 w. Min Rept—Feb. 28, 1907. Serial. 1st part. No. 82748.

Zinc Mining in Mississippi Valley. E. Hedburg. Describes the deposits and gives information relating to the earnings from these mines. Ills. 1500 w. Min Wld—March 2, 1907. No. 82754.

Zinc in Eastern Tennessee. W. C. Clark. Describes the location of the deposits, nature of the ores, work done, etc. 1500 w. Mines & Min—April, 1907. No. 83397 C.

We supply copies of these articles. See page 316.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accounting.

Railway Records. U. H. Clarke. First of a series of articles on accounting and office records of the motive power department. 3500 w. Ry Mas Mech—March, 1907. Serial. 1st part. No. 82866.

Curves.

Danger to High Speed Trains on Curves. Richard T. Dana. Gives the results of a theoretical investigation of the general problem inspired by the recent accident on the New York Central R. R. 1500 w. Engng-Con—March 27, 1907. No. 83274.

Disasters.

Report on the Derailment of the "Pennsylvania 18-Hour Special" at Mineral Point, Pa.; Removal of Steel Cross-Ties. Gives the report of the investigating committee, with editorial, and an explanation of the ordered removal of the steel cross-ties. 2000 w. Eng News—March 7, 1907. No. 82798.

The New York Central Accident Investigation and the Action of Railway Trains on Curves. Editorial discussion of this accident with an outline of facts in connection with railway curve mechanics. 3800 w. Eng News—March 7, 1907. No. 82799.

Wreck of an Electric Train on the New York Central. An illustrated account of this accident and discussion of its cause. 1800 w. Sci Am—March 2, 1907. No. 82644.

Some Facts and Figures Bearing on the Bronx Park Derailment on the New York Central. Gives a summary of the three investigations of the accident that have been in progress and of the results. 5000 w. Eng News—March 14, 1907. No. 83139.

D., L. & W. Report.

Delaware, Lackawanna & Western. Reviews the report of this road for 1906. 2000 w. R R Gaz—March 1, 1907. No. 82679.

Italy.

Italian Government Railways. Thomas F. Millard. A brief review of conditions in Italy, explaining the circumstances which led to the taking over of the railway management by the government, and the results thus far. 1500 w. Ry Age—March 22, 1907. No. 83257.

Rules.

Working Regulations for Boston & Maine Enginemen. Gives the new code of rules adopted governing the conditions under which these men are to work. 2700 w. R R Gaz—March 1, 1907. No. 82680.

Transportation.

The Transportation Crisis. Lewis M. Haupt. First of a series of papers dealing with railroad development, relative freight rates in the United States and European countries, the danger of restrictive legislation, and the importance of regulating transportation facilities by the improvement of inland waterways. 2300 w. Mfrs' Rec—March 28, 1907. Serial. 1st part. No. 83299.

MOTIVE POWER AND EQUIPMENT.

Air Brake.

The New Continuous Air Brake (Le nouveau Frein Continu Pneumatique). C. Dantin. Detailed description of the mechanism and working of the Chapsal-Saillot brake. Ill. 2600 w. Génie Civil—Mar. 16, 1907. No. 82970 D.

Boilers.

Boilers for Railway Motor Cars. Illustrates and describes some of the more successful types of boilers used on the steam motor cars of England. 1200 w. Boiler Maker—March, 1907. No. 82678.

Brakes.

Mechanical Power Storage Brake. Illustrated description of this solution of the brake problem. 1800 w. Tram & Ry Wld—March 7, 1907. No. 83192 B.

Car Heating.

Heating Systems for Railway Cars. Prof. R. C. Carpenter. An illustrated paper discussing processes and methods of operation. 4000 w. Heat & Vent Mag—March, 1907. No. 83174.

Heating Trains by Steam (Nots sur l'Application du Chauffage des Trains par la Vapeur). M. Hallard. Describes the Heintz system in use on the lines of the Chemin de Fer du Midi, the apparatus used and the working of the system. Ill. 2400 w. Rev Gen des Chem de Fer—Feb., 1907. No. 82990 G.

Car Repairs.

Repairs to Steel Freight Cars. J. F. MacEnulty. Read before the New England R. R. Club. Illustrates some wrecked steel cars and discusses the cost of repairs and their care. 1600 w. Ir Trd Rev—March 7, 1907. No. 82786.

Cars.

Standard 40-Ton Box Car. Drawings and detailed description of a design for the New York Central lines; 6,000 cars having been ordered. 800 w. Am Engr & R R Jour—March, 1907. No. 82782 C.

We supply copies of these articles. See page 316.

Steel Passenger Cars. Illustrated description of the all-steel type passenger car for use in suburban service on the N. Y. C. & H. R. R. R. 2500 w. Am Engr & R R Jour—March, 1907. No. 82779 C.

Electrification.

On the Substitution of the Electric Motor for the Steam Locomotive. Lewis B. Stillwell and Henry St. Clair Putnam. The purpose of the paper is to record facts relative to heavy electric traction; to present calculations of costs; to show the importance of standardizing equipment; and to consider whether 25 or 15 cycles per second should be adopted in railway operation by alternating-current motors. 20800 w. Pro Am Inst of Elec Engrs—Jan., 1907. No. 83023 D.

On the Substitution of the Electric Motor for the Steam Locomotive. Editorial letter from Lewis B. Stillwell and H. S. Putnam in reply to a letter from G. B. Henderson, discussing features of the author's paper on this subject. 3500 w. St. Ry Jour—March 16, 1907. No. 83082.

The Substitution of the Electric Motor for the Steam Locomotive. Harrington Emerson. A criticism of conclusions reached by Mr. Lewis B. Stillwell and Mr. Henry St. Clair Putnam, in a recent paper before the Am. Inst. of Elec. Engrs., giving reasons for dissent. 2000 w. Ry Age—March 1, 1907. No. 82704.

Electrification of Steam Railroads. H. Ward Leonard. Quotes from letter by J. J. Hill which claims the great need of additional tracks, and claims that freight congestion can be relieved by increase of speed and loads. Advocates an International Electric Railway Commission to consider questions of trunk line electrification and solution of traffic congestion 1300 w. Elec Wld—March 16, 1907. No. 83128.

The Progress of Electricity on Steam Roads in 1906. Bion J. Arnold. Presidential address. Outlines work accomplished, in progress, and planned for the electrification of terminals and lines, and other great improvements such as the construction of tunnels, building of power stations, etc. 6000 w. Jour W Soc of Engrs—Feb., 1907. No. 83183 D.

Electric Traction for Steam Roads (Le Traction Electrique appliquée aux Chemins de Fer). M. N. Mazen. Comprehensive paper on the present state of heavy electric railway practice all over the world. Illus. 2 plates. 9800 w. Mem de la Société des Ingénieurs Civils de France—Dec., 1906. No. 82905 E + F.

Electric Traction for Steam Roads (La trazione elettrica sulle ferrovie). Pietro Lanino. Enumeration of most important electric installations on European and American railways. 3000 w. L'Elettricita—Jan. 25, 1907. No. 82903 D.

Locomotives.

Compound v. Simple Locomotives. A statement of facts and arguments bearing on this question, and aiding in determining whether, or not, compounding would be of service. 3300 w. Engr, Lond—March 1, 1907. No. 83004 A.

Counterbalancing the Balanced Compound Locomotive. O. W. Ott. Gives an example taken from actual practice. 1200 w. Ry Mas Mech—March, 1907. No. 82867.

Compound for the Mexican National. Illustration, with principal features of the design of a balanced compound Pacific type locomotive. 500 w. Ry & Loc Engng—March, 1907. No. 82698 C.

Consolidation Locomotive for the Nippon Tetsudo Kwaisha Railroad. Illustrated detailed description of an engine built in America for the narrow-gauge railroads of Japan. 800 w. R R Gaz—March 8, 1907. No. 82802.

The 4-Cylinder Locomotive in Great Britain. Charles S. Lake. Discusses the value of this locomotive in its compound and non-compound type, urging that it be given an impartial trial. 2000 w. Mech Engr—March 16, 1907. No. 83261 A.

Four-Cylinder Non-Compound Engine—Great Western Railway. Drawings, with brief note. 200 w. Engr, Lond—Feb. 22, 1907. No. 82841 A.

British-Built Locomotives for Service Abroad. Charles S. Lake. Introductory remarks on the British export trade, with illustrated description of some recently completed locomotives. 1200 w. Mech Engr—March 2, 1907. No. 82887 A.

A High-Speed Bavarian Locomotive. William Mayner. Illustration and short description of an engine exhibited at Nürnberg, designed for a normal speed of 94 miles an hour. 600 w. Sci Am—March 9, 1907. No. 82806.

German Tank Engines. Brief illustrated descriptions of a standard gauge and a narrow gauge engine for industrial railway service. 300 w. Ry & Loc Engng—March, 1907. No. 82699 C.

The Four-Cylinder Express Locomotives of the Danish State Railway. O. Busse. Chief dimensions and illustrated description. 1600 w. Bul Int Ry Cong—Feb., 1907. No. 83290 E.

Santa Fe Type Locomotive with Smokebox Superheater. Illustrated detailed description of a very heavy simple 2-10-2 locomotive for the P. S. & N. R. R. 800 w. Am Engr & R R Jour—March, 1907. No. 82780 C.

Tank Engine for the Nevada Northern. Illustrates and describes a suburban tank

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engine of the 2-8-2 type. 600 w. Ry & Loc Engng—March, 1907. No. 82701 C.

A Snow Locomotive for Logging Work. Illustrated description of an interesting engine for hauling logs on sleds over hard-packed snow. 600 w. Eng News—March 14, 1907. No. 83135.

Mallet System.

New Applications of the Mallet System to powerful American Locomotives (Nouvelles Applications du Système Mallet aux Locomotives Américaines de grande puissance). Henry Martin. Illustrated detailed description of Great Northern, Erie, and Baltimore and Ohio locomotives built on this system. Ill. 5500 w. Génie Civil—Feb. 9, 1907. No. 82986 D.

Motor Car.

Motor Cars with Gas Engine—Electric Motor Power Plant (Motorwagen mit elektrischer Kraftübertragung im Eisenbahnbetriebe). P. Poschenrieder. A car for use on steam roads in Austria. Enumeration of motor cars for steam roads and their performances in service. Illus. 4400 w. Elektrotechnische Zeitschrift—Feb. 28, 1907. No. 82965 B.

Rail Car.

A Flat Car for the Transport of Rails (Note sur un Wagon Platforme destine au Transporte des Dails de 15 à 24 mètres de longuer). M. M. Lambert. Gives a general description of this car and illustrates the more important structural details. Ill. 1700 w. Rev Gen des Chem de Fer—Feb., 1907. No. 82991 G.

Royal Train.

Metre-Gauge Royal Train for India. Illustrated description of the carriages of a train constructed for the special use of the Prince and Princess of Wales during their recent visit to India. 1000 w. Engng—March 8, 1907. Serial. 1st part. No. 83115 A.

Snow-Ploughs.

Snow-Plough for the Caledonian Railway. Illustrated description of an improved form of wedge-shaped plough. 300 w. Engng—March 8, 1907. No. 83116 A.

The Rotary in the Rockies. An illustrated article describing the large rotary snow plows used, and the work they accomplish. 1000 w. Ry & Loc Engng—March, 1907. No. 82697 C.

Train Control.

New Method of Controlling the Speed of Trains (Een nieuw toestel voor de contrôle van de snelheid van treinen). H. P. Maas Geesteranus. Illus. 3900 w. De Ingenieur—Feb. 2. 1907. No. 82956 D.

Train Lighting.

See Electrical Engineering, Light.

Valves.

The M Triple Valve. Illustrated description of this valve as applied in the electrification of the Rochester branch of the Erie Railroad. 1200 w. Ry & Loc Engng—March, 1907. No. 82702 C.

Wheels.

The Chilled Cast Iron Wheels. W. E. Fowler. Read before the Canadian Ry. Club. Discusses the wearing qualities, design, manufacture, and related matters of interest. 2500 w. Can Engr—March, 1907. No. 82696.

NEW PROJECTS.

Africa.

A New Trans-African Railroad from the Atlantic Seaboard to Lake Tanganyika. Illustrated detailed description of an important new line under construction, which will become an important factor in the development of a rich mineral district. 2800 w. Sci Am Sup—March 23, 1907. No. 83154.

Alaska.

Railway Routes in Alaska. Alfred H. Brooks. A discussion of railway projects, the location of lines, cost per mile, resources to be developed, minerals, agricultural possibilities, etc., showing there is justification for a trunk line railway from the Pacific seaboard to inland points. Maps and illustrations. 7000 w. Nat Geog Mag—March, 1907. No. 83295 C.

Australia.

Two New Australian Main Line Railways. Discusses the proposed transcontinental railway, 1,100 miles in length; and the main line to develop the northern coast of New South Wales, 311 miles long. 2400 w. Engr, Lond—Feb. 22, 1907. No. 82839 A.

Consolidation.

The Indianapolis Southern Railroad. Illustrated description of a consolidated line formed by a recently built line between Indianapolis and Switz City, Ind., and the Effingham district of the Illinois Central R. R. 2500 w. R R Gaz—March 15, 1907. No. 83058.

Cut-Offs.

The Bay Shore and Dumbarton Cut-Offs of the Southern Pacific. An illustrated description of these improvements which include the construction of tunnels, improvements of grades and curves, and secures a direct and easier entrance into San Francisco for the trains of the Coast division. 2200 w. R R Gaz—March 15, 1907. No. 83057.

The Genesee River Cut-Off of the Erie Railroad. Construction of a low-grade line between Hornell and Cuba is illustrated and described. 3000 w. Eng Rec—March 2, 1907. No. 82738.

Grand Trunk Pacific.

Location Surveys for the Eastern Half of the Grand Trunk Pacific. An account of the surveys of this new line taken from

a recent address by H. D. Lumsden. 2500 w. R R Gaz—March 29, 1907. No. 83326.

Great Britain.

Current Railway Construction. An account of improvement and extensions in progress on British railways. 2700 w. Engng—March 8, 1907. No. 83118 A.

Improvements.

Norfolk & Western Improvement Work. George L. Fowler. Illustrated detailed description of reconstruction, double-tracking, improved grades and alinement. 5000 w. R R Gaz—March 15, 1907. Serial. 1st part. No. 83061.

Improvements and Extensions of the Union Pacific During 1906. R. L. Huntley. Map and information of work in Nebraska and Wyoming, including double-tracking, cut-offs, branch extensions, etc. 5400 w. Ry Age—March 22, 1907. No. 83253.

Bronx Improvement of the New York Central. Illustrated description of improvements involving a rearrangement of tracks and the building of a new station at Mott Haven. 1200 w. Ry Age—March 22, 1907. No. 83252.

Yonkers Improvement of the New York Central. Illustrates and describes very extensive changes, including the re-location of tracks, construction of extra tracks, elimination of grade crossings, new station, etc., explaining the conditions to be met. 1800 w. Ry Age—March 22, 1907. No. 83256.

The Pennsylvania Railroad Improvements Between Philadelphia and Baltimore. The principal feature is a new steel and masonry bridge, over the Susquehanna River. Also changes for the elimination of grade crossings, and the reducing of grades and curvature. 1000 w. Eng Rec—March 9, 1907. No. 82861.

Improvement Work on the Southwest System, Pennsylvania Lines. Describes an extension of the double-tracking, elimination of grade crossings, construction of coaling and water stations, etc. Ills. 1800 w. Ry & Engng Rev—March 16, 1907. No. 83091.

Improvements on the P. B. & W. R. R. at Havre de Grace, Md. Illustrates and describes details of this work, especially the new steel and masonry bridge over the Susquehanna River, at Havre de Grace. 1400 w. Ry & Engng Rev—March 23, 1907. No. 83249.

Tehuantepec.

The New Tehuantepec Railroad (Le nouveau Chemin de Fer de l'Isthene de Tehuantepec). A. Dumas. The history of the project, a description of the country through which the line passes, the harbour works at the terminals and other related matters. Ill. 3200 w. Génie Civil—Feb. 16, 1907. No. 82893 D.

Virginia.

The Tidewater and the Deepwater Railways. Maps and illustrated description of this line which will connect the West Virginia coalfields with tide water at Norfolk, Va. 9300 w. R R Gaz—March 15, 1907. No. 83060.

PERMANENT WAY AND BUILDINGS.

American.

American Railroads (Note sur les Voies Américaines). M. Descubes. Discusses rails, ties, methods of laying track, and other details of the roadbeds of American railways and compares with European practice. Ill. 3500 w. Rev Gen des Chem de Fer—Feb., 1907. No. 82992 G.

Chihuahua.

The Construction of the Chihuahua & Pacific Railroad. F. Lavis. An illustrated description of the work on the first section of this Mexican railway, which is extremely well built. 2800 w. Eng Rec—March 2, 1907. No. 82712.

Coaling Plant.

Coaling Plant with Dredge-Bucket at Cologne Station (Bekohlanlage mit Greifer auf dem Bahnhof Köln). C. Guillery. A coaling plant mounted on a traveler and provided with a drop bucket. Illus. 1500 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 23, 1907. No. 82919 D.

Curves.

Centrifugal Force on Curves and Its Resistance by Track. A study of the problem of track strength on curves made in connection with investigations of the recent accident on the New York Central Ills. 1200 w. Eng Rec—March 16, 1907. No. 83068.

Stresses in Tracks on Curves. A study of the mechanics of curve resistance, giving an outline of the calculations. 1700 w. R R Gaz—March 15, 1907. No. 83056.

The Relation of Locomotive Wheel Base to Track Curvature. George R. Henderson. A discussion of the effect of rigid wheel base and the corresponding clearances. 1200 w. Ry Age—March 8, 1907. No. 82873.

Otavi.

The Otavi Railway (Die Otavi-Bahn). M. Wechsler. Description of the location, construction, permanent way and rolling stock of a line recently opened in German Southwest Africa. Illus. 1 plate. Serial. 2 parts. 7800 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 9 and 23, 7907. No. 82921 each D.

Shops.

Battle Creek Shops of the Grand Trunk Ry. General view, plan and detailed description. 2500 w. Ry & Engng Rev—March 9, 1907. No. 82874.

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Signalling.

Government Report on the Block System. Extracts from the last report of the Interstate Commerce Commission, dealing with automatic stops and other appliances not in general use, and those containing conclusions and recommendations of the commission. Also the mileage of railroad worked by the block system. 7000 w. R R Gaz—March 1, 1907. No. 82682.

Report on Block Signals. A review of the report of the interstate commerce commission on "Block Signal Systems and Appliances for the Automatic Control of Railway Trains." 3800 w. Ry Age—March 15, 1907. No. 83083.

Automatic Electric Block Signaling on the Boston & Maine Ry. Illustrated description of the double-blade electric semaphore block signals installed, with extracts from specifications. 2000 w. Eng News—March 7, 1907. No. 82797.

New and Old Signaling Problems. W. H. Elliott. Read before the N. England R. R. Club. Considers some of these problems, offering suggestions. 6000 w. R R Gaz—March 22, 1907. No. 83210.

New Signals on the Pennsylvania. Illustrates and describes the signalling equipment recently installed near Philadelphia, embodying the principle of upwardly inclined semaphore blades. Also editorial. 4000 w. Ry Age—March 15, 1907. No. 83084.

Upward-Inclination, Three-Position Signals, on the P. B. & W. Photographs, drawings and description of the installation of automatic block signals recently put in service. 2500 w. R R Gaz—March 15, 1907. No. 83063.

Steel Sleepers.

A Longitudinal Steel Sleeper System for Railroad Tracks. Gustav Lindenthal. Illustrated description of a steel foundation for railroad tracks, being tested on the Pennsylvania R. R. at Pomeroy Station. 1200 w. R R Gaz—March 15, 1907. No. 83059.

Switches.

Switch-Closing Devices and Switch Protection on Main Tracks. Editorial discussion of switch-closing devices, their dangers and advantges, and the protection of trains at turnouts. 2200 w. Eng News—March 28, 1907. No. 83323.

Switches and Turnouts Howard Chapin Ives. The present article presents a study of the frog, the switch, the lead rails on straight main track. 1600 w. Jour Worcester Poly Inst—March, 1907. Serial. 1st part. No. 83277 C.

Terminals.

The Theory of the Design of Railway Freight Terminals. H. M. North. Discusses the demands upon a freight terminal yard, the general types, the theory of design, the gravity yard, etc. 10400 w. Jour W Soc of Engrs—Feb., 1907. N.o 83187 D.

The Opening of the Lackawanna Terminal at Hoboken. Illustrations, and remarks on specifications of this fine terminal. 500 w. Ry Age—March 1, 1907. No. 82707.

The Present Condition of the Railway Terminal at Washington. Illustrated description, showing the progress made. 1800 w. Eng Rec—March 23, 1907. No. 83216.

The Flatbush Avenue Terminal of the Long Island Railroad. Chester A. Crandell. Illustrated detailed description of this common terminus of two distinct subways. 900 w. R R Gaz—March 29, 1907. No. 83327.

Ties.

Experiments with Concrete Ties. Report of the American Railway Engineering and Maintenance of Way Association which refers to concrete ties. 4000 w. Elec Ry Rev—March 23, 1907. No. 83237.

Steel Ties in the United States (Versuche mit flusseisernen Querschwellen in den Vereinigten Staaten von Nordamerika). K. A. Müllenhoff. Ties and fastenings described and compared. Illus. 1700 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 16, 1907. No. 82927 D.

Tracks.

A Study of the Stresses Existing in Track Superstructure. O. E. Selby, in Bul. 80 of the Am. Ry. Engng. & Main. of Way Assn. Discusses the unit stresses existing under present conditions, and the requirements for a more durable structure. 3000 w. Eng Rec—March 23, 1907. No. 83214.

Track Deformations and Their Prevention. G. Cuenot. Authorized translation of an account of experimental work undertaken to determine the strength of different kinds of cross-ties, their length, the extent of bed, etc. Also editorial. Ills. 6500 w. R R Gaz—March 15, 1907. No. 83062.

Warehouse.

The Terminal Warehouse of the Louisville & Nashville R. R. at Atlanta, Ga. Describes a 5-story reinforced concrete warehouse just completed. 2000 w. Eng Rec—March 2, 1907. No. 82740.

TRAFFIC.

Car Shortage.

Car Shortage. Arthur Hale. Discusses what is being done, and can be done, to reduce the car shortage. 2400 w. Ry Age—March 1, 1907. No. 82706.

Demurrage.

Reciprocal Demurrage. Editorial on the strong arguments presented by J. M.

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Daly before the committee of the legislature of Iowa. 1500 w. R R Gaz—March 8, 1907. No. 82801.

Reciprocal Demurrage. E. D. Sewall. An argument against it. Also paper by J. M. Daly, and general discussion. 7000 w. Pro Iowa Ry Club—Feb. 8, 1907. No. 83157 C.

Reciprocal Demurrage. The statement before the committee of the Alabama legislature by Milton H. Smith, explaining the demurrage principle and the reasons why reciprocal demurrage is unfair. 3000 w. R R Gaz—March 8, 1907. No. 82803.

Immigrant Traffic.

Handling Immigrant Traffic at the Port of New York. An interesting illustrated article showing the care given immigrants by the government and the officials of the steamship lines and railroads. 3000 w. R R Gaz—March 8, 1907. No. 82804.

Rates.

Passenger Rate Regulation and the Canadian Parliament. S. J. McLean. A discussion of attempts being made to deal with passenger rates in Canada. 2000 w. R R Gaz—March 8, 1907. No. 82805.

An Increase in Freight Rates. Editorial presenting a summary of reasons why freight rates should be increased, and of objections to an increase, with facts presented by men in authority and conclusions. 2200 w. R R Gaz—March 29, 1907. No. 83324.

MISCELLANY.

Ash Handling.

The Ash Handling Plant of the Delaware, Lackawanna & Western R. R. at Scranton, Pa. Brief illustrated description of an efficient plant where frequently 300 engines are cleaned in a day. 800 w. Eng Rec—March 16, 1907. No. 83069.

Convention.

The Engineering and Maintenance of Way Association Convention. Abstracts of discussions, reports, and general business. 7000 w. R R Gaz—March 29, 1907. No. 83325.

India.

Notes on Indian Railway Systems. Abstracted from the Indian Government Railway Returns. Information relating to the railway systems, their equipment, operation, etc. 1600 w. Jour Soc of Arts—March 8, 1907. Serial. 1st part. No. 83096 A.

STREET AND ELECTRIC RAILWAYS

Car House.

The Broadway Car House of the International Railway Company. Thomas Pumfrey. Illustrates and describes the construction features of this new car house at Buffalo, N. Y. 3000 w. St Ry Jour—March 23, 1907. No. 83236.

Contact Wires.

A New Form of Suspension for Contact Wires. Discusses the strains in the contact wire and their effect, and illustrates and describes a new design for a suspender. 3300 w. R R Gaz—March 1, 1907. No. 82681.

Dispatching.

Dispatching Cars by Telephone, Denver City Tramway. S. W. Cantril. An explanation of the system and a description of the method of dispatching cars by telephone. Ills. 2000 w. Elec Ry Rev—March 2, 1907. No. 82747.

Earth Currents.

Some Theoretical Notes on the Reduction of Earth Currents from Electric Railway Systems by Means of Negative Feeders. George I. Rhodes. Considers the relative efficiencies of different return feeder systems in reducing stray currents. 1600 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83045 D.

Electric Locomotives.

Electric Locomotives for Heavy Service. An illustrated article calling attention to some interesting features of recent American-built machines. 1600 w. Elec Rev, N Y—March 23, 1907. No. 83223.

Electric Traction.

Electric Freight Locomotive Built by the Brooklyn Rapid Transit Company. Illustrated description of a large electric locomotive to be used for hauling as many as twenty freight cars from South Brooklyn to Coney Island, about 5 miles distant. 900 w. St Ry Jour—March 23, 1907. No. 83234.

New Electric Locomotives of the Boston Elevated Railway Company. Illustrated description of electric locomotives recently designed for heavy yard and general haulage service. 1000 w. St Ry Jour—March 2, 1907. No. 82685.

Development of Electric Traction (Le Dèveloppement de la Traction Electrique). M. De Valbreuze. Discussion of a paper on this subject read before the Société Internationale des Electriciens. Ill. 7500 w. Bul Soc Int d Elecns—Feb., 1907. No. 82981 F.

Interurban.

Electric Traction on Local Lines (La Traction Electrique sur les Lignes de Chemin de Fer d'Intérêt local). Eric Gérard. Discusses advantages and disadvantages of different types of current,

We supply copies of these articles. See page 316.

transmission lines and other details of electric traction. 4000 w. Soc Belge d'Elec—Feb., 1907. No. 82988 F.

Operation and Construction of the Elgin & Belvidere Railway. R. H. Rice. Illustrated detailed description of this high-speed line in Illinois. 2000 w. Elec Ry Rev—March 9, 1907. No. 82870.

The Construction of the Bennington & North Adams Street Railway. Charles Rufus Harte. This line closes a gap in the trolley lines between Great Barrington, Mass., and Hoosick Falls, N. Y. Illustrated description of construction under many difficulties. 2000 w. Eng Rec—March 2, 1907. No. 82739.

The Manchester & Nashua Street Railway. Illustrated description of an important electric interurban line in southern New Hampshire. 2200 w. Elec Ry Rev—March 16, 1907. No. 83080.

The Evansville, Suburban & Newburgh Railway. Describes interesting features in the construction and operation of this line in Indiana, which gives steam freight service in addition to electric operation of passenger trains. Ills. 3500 w. St Ry Jour—March 16, 1907. No. 83081.

London.

The Rapid Transit Systems of London. Notes on recent improvement of transit facilities, especially considering motor omnibuses, electric street railways, and underground railways. Ills. 5000 w. Eng News—March 21, 1907. No. 83197.

Milan Exposition.

Electric Railways at the Milan Exposition (Die elektrischen Bahnen auf der Ausstellung in Mailand, 1906). A. Zweiling. Description of Europen practice as shown by cars, motors, etc., at Milan. Illus. 11400 w. Serial. 1st, 2d and 3d parts. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 2 and 16, and March 2, 1907. No. 82917 each D.

Municipal Ownership.

The New Orleans Public Belt Railroad. Map, description, and general information in regard to this belt railway which will encircle the greater part of the city. 1800 w. Ry Age—March 22, 1907. No. 83255.

Nashville, Tenn.

New Car House and Shops at Nashville. Illustrated description of well-designed buildings for shop and car-storage purposes. 1600 w. Elec Ry Rev—March 2, 1907. No. 82746.

Philadelphia.

Opening of the New Market Street Elevated Railway of the Philadelphia Rapid Transit System. Edward Hungerford. An account of the opening of the line, with illustrated description of the subway section, the elevated section, local stations, terminal stations, equipment and signals. 2800 w. Elec Ry Rev—March 9, 1907. No. 82869.

Power Stations.

Steam Power Station, Twin City Rapid Transit Company, Minneapolis, Minn. Illustrated detailed description of a plant which operates in parallel with a water-power station of 10,000 h.p. capacity located about 1,000 ft. away. Together they furnish power to ten electric railway sub-stations. 3000 w. Pro Am Inst of Elec Engrs—Feb., 1907. No. 83042 D.

The Power Plant of the Spokane & Inland Empire R. R. Co. William F. Zimmermann. Brief illustrated description of this power development in the State of Washington. 1300 w. Eng Rec—March 2, 1907. No. 82718.

Shops.

Shops of the North Jersey Division of the Public Service Corporation. Illustrated detailed description of a large and finely equipped plant for shop work and car storage. 2000 w. Elec Ry Rev—March 16, 1907. Serial. 1st part. No. 83079.

Shop Practice at Memphis. An illustrated account of the work in these reorganized street railway shops during the last two years. 4000 w. St Ry Jour—March 2, 1907. No. 82684.

Signalling.

Power Signalling as Installed by the Underground Electric Railways Co., of London. Illustrated detailed description of the automatic signalling system. 2500 w. Elec Rev, Lond—March 15, 1907. Serial. 1st part. No. 83265 A.

Simplon.

The Electrification of the Simplon Tunnel Railroad. An illustrated description of this work and the methods of operating. 4000 w. Sci Am Sup—March 16, 1907. No. 83020.

Electrical Equipment of the Simplon Railway (Der Elektrische Betrieb der Simplon-Bahn). H. Rupp. Description of the line, overhead construction, locomotives, etc. Illus. Serial. 2 parts. 6900 w. Zeitschrift des Vereines Deutscher Ingenieure—Feb. 9 and Mar. 9, 1907. No. 82925 each D.

Stations.

The Passenger Stations of the Hudson Companies. Brief illustrated description of the plans for the passenger stations in New York, Jersey City and Hoboken. 800 w. St Ry Jour—March 9, 1907. No. 82846.

Surface Contact.

The Dolter Surface-Contact System. Illustrated description of the application of this system to tramways at Torquay, Mexborough and Hastings, in England. 3500 w. Tram & Ry Wld—March 7, 1907. No. 83191 B.

We supply copies of these articles. See page 316.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or twelve for $2.00, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *w.* Chicago.

Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Klijk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.

CURRENT RECORD OF NEW BOOKS

NOTE—Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to THE ENGINEERING MAGAZINE.

Coal.

The Peabody Atlas, Shipping Mines and Coal Railroads in the Commercial District of the United States. By A. Bement. Size, 18 by 17 in.; pp. 149. Maps, 25. Ill. Price, $5.00. Chicago: Peabody Coal Co.

A valuable collection of geological, statistical, economic and commercial data of coal production and producers in the eastern United States. Especially important is its lists of working coal mines and their railway relations. An appendix with 47 figures is devoted to smokeless combustion and smoke-prevention devices.

Fire-Proof Construction.

The San Francisco Earthquake and Fire. By A. L. A. Himmelwright. Size, 9½ by 11 in.; pp. 270. Ill. Price, $5.00. New York: The Roebling Construction Co.

An engineer's report of the results of investigations made in San Francisco shortly after the earthquake and fire. Illustrates and describes eighty of the more important buildings, both fire-proof and non-fire-proof, in the burned district, giving more or less full details of the construction and the effects of the fire and the earthquake, with comments on the special features presented in each case. An effort is made "to point out those methods and details of construction which developed good efficiency in the fire and the earthquake; to call attention to those features of construction which were either defective or failed to fulfil the requirements; and to note important omissions in the designs." A final section gives a summary of the information obtained and outlines the valuable lessons which may be learned from the effects of the disaster. The volume contains a very large number of excellent illustrations.

Lathe Practice.

Modern American Lathe Practice. By Oscar E. Perrigo. Size, 9 by 6 in.; pp. 424. Ill., 315. Price, $2.50. New York: Norman W. Henley Publishing Company.

The history of the development of the lathe is traced from its crudest beginning to its present position as an intricate and highly efficient machine. The various types of lathes are carefully classified and their special features of design, construction and use are pointed out and briefly commented upon. A large part of the volume is devoted to a thorough discussion of lathe design and, in this, no essential element is overlooked. Tools, tool steels, and lathe testing and operation are discussed and in the final chapters the more important of the lathes at present on the market are described and compared. The book is a very complete treatise on this particular type of mechanical appliance and should prove valuable as a book of reference alike to the student, the designer, the mechanic, and the manufacturer and purchaser of lathes. It contains a large number of illustrations made especially for this work.

Municipal Ownership.

The Dangers of Municipal Ownership. By Robert P. Porter, Director of Eleventh U. S. Census. Size, 8¼ by 5¾ in.; pp. xi, 356. Price, $1.80. New York: The Century Co.

The book was prepared in Great Britain, being based largely upon addresses delivered by the author before the British Association, the British Society of Arts, the London School of Economics and the London Chamber of Commerce. It is essentially a summary of British experience during the thirty years or more of "municipal trading" which are now available for study, with collateral examination of the results of the same policy on the Continent and in the Colonies, especially Australasia. A very strong case against the policy is established, on the grounds that it furnishes very inefficient and unprogressive service, rolls up a huge public debt, and strangles industrial enterprise.

Panama Canal.

Problems of the Panama Canal. By Brig.-Gen. Henry L. Abbot. New edition, revised. Size, 9 by 6 in.; pp. xii, 261. Figures, xv. Map. Tables. Ill. Price, $2.00 net. New York: The Macmillan Company. London: Macmillan & Co., Ltd.

Revised and enlarged from the original edition of 1905, with a new chapter on

"The Canals under the Control of the United States," a new section of chapter 7 discussing the projects of the Board of Consulting Engineers, additional climatological and hydraulic data covering the two and one-half years elapsed since the first edition appeared, and eight half-tone plates. It brings the history of the undertaking down to the opening of 1907, supplying an admirable review of the engineering studies and effort from the inception of the enterprise, and the technical data of "every essential element having a bearing upon the construction of the best possible canal."

Steam Engineering.

Modern Steam Engineering. By Gardner D. Hiscox. Size, 9 by 6 in.; pp. 487. Ill. Price, $3.00. New York: Norman W. Henley Publishing Company.

The aim of the author has been to produce a book which would "fully meet the wants of the student and engineer in all the practical requirements for obtaining a mastery in the application and use of steam for power and other purposes in the full range of its usefulness." With a view to the requirements of the practical man, the mathematical side of steam engineering has been simplified as much as possible and chapters are added on the duties of an engineer, and on the practical care and management of elevators and of refrigeration and electric-light plants. A large number of typical questions asked by licensing boards are given with full answers. Chapters on superheated steam and the steam turbine bring the work fully up to date and round out an extremely practical and well written treatise. The large number of excellent illustrations add greatly to the value of the work as a book of reference for students.

Steam Turbines.

Steam Turbines. By Lester G. French. Size, 9 by 6 in.; pp. vi, 418. Ill. Price, $3.00. Brattleboro, Vt.: The Technical Press.

A large part of the material contained in this volume was collected by the author during the nine years of his editorship of *Machinery* and several articles which appeared in that publication are here reproduced in more or less modified form. The greater part of the matter, however, has been written especially for this work. The author aims to treat the subject from the point of view of the practical man and to this end mathematical discussions have been introduced only where absolutely necessary and graphical solutions have been used wherever possible. Comprehensive historical and descriptive information is given and much attention has been devoted to results of tests upon the flow of steam, upon the action of steam on vanes, and upon the economic properties of turbines. Chapters on the Commercial Aspect of the Turbine and the Status of the Marine Turbine bring the work fully up to date.

Steel.

The Manufacture and Properties of Iron and Steel. By Harry Huse Campbell. Fourth Edition. Size, 9 by 6 in.; pp. xxvi, 639. Figures, lxxi. Tables, ccxlv. Price, $5.00. New York and London: Hill Publishing Company.

The latest edition of this standard work on the metallurgy of iron and steel, like its predecessors, aims to present the permanent fundamental principles of the subject rather than descriptions of apparatus and processes which are subject to constant alteration. In the main, it resembles former editions in subject matter and arrangement. In order to keep the size of the book within the limits of convenience, all unnecessary phrases or words have been eliminated, and some of the matter contained in previous editions has been omitted from the present volume. On the other hand, new knowledge has been interpolated in a hundred places, notably in the chapter on the Influence of Certain Elements on the Physical Properties of Steel.

Technical Dictionary.

Illustrated Technical Dictionary, in Six Languages. Compiled by K. Deinhardt and A. Schlomann; edited by P. Stülpnagel. Size, 7 by 4 in.; pp. 403. Ill. Price, $2.00. New York: McGraw Publishing Co. London: Archibald, Constable & Co.

The first of a series of illustrated technical dictionaries, each to be devoted to a specialized branch of engineering. The volume in hand takes up machine elements and tools, and following books will cover electric plants, steam boilers and engines, hydraulic appliances, hoisting and conveying machinery, machine tools, structural ironwork, metallurgy, architecture, and marine engineering. The method of definition is the simple, visual one of making a picture of the object—the only plan feasible in this peculiar field. Beside the cut are placed the equivalent terms in English, French, German, Russian, Italian, and Spanish. Objects are grouped by their natural mechanical or structural associations. At the back of the book an alphabetically arranged word list refers the consultant to the page and position where any given term will be found. A test of its completeness made by taking a good number of terms at random indicates painstaking thoroughness on the part of the compilers and the editor. Those who have attempted tech-

nical translation know best how sorely an accurate work of this kind has been needed and how warmly it should be welcomed.

Tests.

Bulletins of the Engineering Experiment Station, University of Illinois. Volume I. Size, 9 by 6 in.; pp. about 450, with many illustrations, figures, and tables. Urbana: The University of Illinois.

An assembly into one volume of the most important work of the Experiment Station from Sept., 1904, to Sept., 1906, covering Bulletins 1 to 8 and circulars 1 and 2. The subjects included are: Tests of Reinforced Concrete Beams; High-Speed Tool Steels; Tests of High-Speed Tool Steels on Cast Iron; Drainage of Earth Roads; The Engineering Experiment Station of the University of Illinois; Tests of Reinforced Concrete Beams, Series of 1905; Resistance of Tubes to Collapse; Holding Power of Railroad Spikes; Fuel Tests with Illinois Coals; Tests of Concrete: I. Shear. II. Bond.

BOOKS RECEIVED.

Motori a Gas. By Vittorio Calzavara. Size, 6 by 4 in.; pp. xxxi, 415. Ill. Price, L 4.50. Milan: Ulrico Hoepli.

Carboni Fossili Inglesi. By Guglielmo Gherardi. Size, 6 by 4 in.; pp. xvi, 586. Ill. Price, L 6. Milan: Ulrico Hoepli.

Stampaggio a Caldo e Bolloneria. By Gino Scanferlá. Size, 6 by 4 in.; pp. viii, 165. Ill. Price, L 2. Milan: Ulrico Hoepli.

Alternating Currents. By Alfred Hay. Size, 8½ by 5½ in.; pp. xiv, 291. Ill. Price, $2.50. New York: D. Van Nostrand Company.

Catechism on Producer-Gas. By Samuel S. Wyer. Size, 7 by 4½ in.; pp. 42. Ill. Price, $1. New York: McGraw Publishing Company.

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